ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering.

Vol. XLVIII. No. 12.

TABLE OF CONTENTS.

(24 pages and insct.)

ENGINEERING NEWS OF THE WEEK.....201, 215
The New York Rapid Transit Railway IX.. Contract Section IV. (illustrated)..... 202
Annual Meeting of the International Mining Congress..... 207
The Report on U. S. Irrigation Investigations for 1900 (illustrated) 208
Notes on the History of Turbine Development in America 208
A Trolley-Car Street Sprinkler with Spray Reinforced by Compressed Air (illustrated)..... 210
Annual Convention of the New England Water-Works Association..... 210
One Cause of Leaky Locomotive Flues..... 215
Reports of Committees of the New England and the American Water-Works Associations on Private Fire Protection 216
The Care of Locomotive and Car Scrap..... 217
The Steel Framework of the Farmers' Bank Building, Pittsburg, Pa. (With two-page plate and other illustrations)..... 217
A New Turbidimeter (illustrated) 220
Annual Convention of the Roadmasters' and Maintenance-of-Way Association 220
A Convenient Machine for Loading Ties (illustrated). 222
The Corrington Air Brake 222
Committee Reports of the Roadmasters' and Maintenance-of-Way Association 223
A Long-Span Three-Hinged Masonry Arch (illustrated) 224
EDITORIAL NOTES..... 212
A Well-Conducted Engineering Society—Standard Specifications for Cast-Iron Pipe—Private Fire Protection from Public Water-Supply Mains—The Demand for Engineers—The Production of the United States Steel Corporation and of Independent Producers—The Difficulty in Obtaining Section Foremen.
EDITORIAL:
Engineers, Contractors and Specifications..... 213
LETTERS TO THE EDITOR..... 214
Progress of the Insurance Engineering Experiment Station—Primary and Secondary Considerations in the Disposal of Sewage—Locating the Center of a Section and Subdividing Land Below a Meander Line—Construction Work on the Mexican Central Ry.—Notes and Queries.

A NEW TRANSATLANTIC STEAMSHIP RECORD has been established for the westward trip by the North German Lloyd steamer "Kronprinz Wilhelm," which left Cherbourg on Sept. 10 and arrived in New York on Sept. 16. Her record for the trip was 5 days, 11 hours and 57 minutes. This breaks the record of 5 days, 12 hours and 29 minutes, made by the "Deutschland" in August, 1900. The distance the "Kronprinz" covered was 3,047 miles, and the average hourly speed 23.09 knots. This breaks the "Deutschland's" best average hourly speed toward the West, which is 23.07 knots. The "Kronprinz Wilhelm" beat her own westward record by 3 hours and 48 minutes.

A SANITARY SEWERAGE SYSTEM for Baltimore, Md., is again proposed. The matter has been laid before the city council by Mayor Hayes, in the form of an ordinance authorizing the work, appropriating money therefor, and providing for the appointment of a sewerage commission. It is proposed to utilize $4,422,461, received by the city from the sale of Western Maryland Railroad, and thus avoid an appeal to the legislature for funds. It is unofficially stated that the mayor believes septic tanks, located nearer the city than the outlets proposed by the old sewerage commission, could be used, thus lessening construction charges. The sewerage commission would consist of six members, including the mayor, five to be appointed by the mayor, with the approval of the second branch of the city council. The commission would

appoint a suitable engineer, of large experience, who shall, together with the commissioner of health, the city engineer, the water engineer, and the chief engineer of the electrical commission,

formulate plans for a sewerage system. The commission would submit the plans to the city council, and after approval by both branches, the commission would be compelled, by the ordinance, to accept them and carry out the work.

A CANAL 5,800 FT. LONG to flush the stagnant waters of Black River at Port Huron, Mich., is now being constructed by the Cuyahoga Contracting Co., of Cleveland, O. The Black River bisects the town of Port Huron, and during the greater part of the year its waters have no flow, and thus become stagnant and a menace to health. It was, therefore, decided to construct a canal from Lake Huron to a point in the river above the town, and thus flush the river whenever it was necessary to do so. This canal is through earth, and is 112 ft. wide at the top, 25 ft. wide at the bottom, has a fall of 14 ins. from end to end, and carries 6 ft. depth of water. Construction was begun in July and is to be completed by March, 1903. The excavation is being done by a Hayward dredge, the parts of which were supplied by the McMyler Mfg. Co., of Cleveland, O., and were put together in the field by the contractors.

REVISED WATER PURIFICATION ESTIMATES for Pittsburg, Pa., have been submitted to the city council, in accordance with the court decision that the estimates must include all parts of the proposed improvement. The revised figures aggregate $3,719,000, including pumps, conduits and meters, as well as settling basins and slow sand filters. As the sum is $1,219,000 in excess of the original appropriation, an additional bond issue must be authorized by popular vote before the work can proceed, but prior to the popular vote the council, which has been holding up the improvements, must sanction the proposition. Mr. Allen Hazen, M. Am. Soc. C. E., of New York, is consulting engineer; Mr. Morris Knowles, Assoc. M. Am. Soc. C. E., is resident engineer, and Dr. Guy McCandless is director of public works.

A DEVICE TO BREAK THE FORCE OF WATER when flushing water mains from hydrants is used in Somerville, Mass., by Mr. F. E. Merrill, President of the New England Water-Works Association, and was brought by him to the recent convention of the association in Boston. The flushing hose is coupled to one end of a perforated pipe, which is capped at the other end. The jets from the perforations impinge upon a second and surrounding pipe, 8 ins. in diameter, open at one end for the discharge of the water under its reduced head and closed at the other end by a cap, through which the perforated pipe extends to the hose coupling. Both pipes are of wrought iron, the outer one some 3½ and the inner 2½ ft. in length.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision between a passenger and a freight train at Struby, seven miles south of Littleton, Colo., on the Atchison, Topeka & Santa Fe R. R. on Sept. 13. Three of the passenger train crew were killed and another probably fatally injured.

THE COLLAPSE OF A BRIDGE under a mail train in India on Sept. 12 caused the death of 50 passengers and the injury of many others. The bridge was located near Mangapatnan, on the Madras-Bombay line, and had been undermined by a flood.

THE EXPLOSION OF A LOCOMOTIVE BOILER on a Pennsylvania R. R. freight engine at the entrance to the Bergen cut near Jersey City, N. J., on Sept. 13, killed the engineer and severely injured the fireman and conductor of the train, all of whom were riding in the locomotive cab. The engine was of the Mogul type, and was comparatively new. According to the most reliable accounts the boiler blew out of the frame without warning and rose bodily in the air, carrying the cab and the three men with it. About 200 ft. away the cab split in two, one-half falling to the right of the track, while the other half fell to the left. The boiler continued its flight 200 ft. further, passing over the westbound track and striking against the granite wall on the north side of the cut. From there it rebounded and fell on the eastbound track. The train ran about 200 ft. by its own momentum before it came to a stop. Neither the wrecked engine nor any of the cars left the track. A singular feature of the accident is that while the rails over which the train had passed and on which it still stood were intact, for a distance of about 30 ft. in advance of the train the rails were so twisted that no cars could traverse them, and the train could not be hauled to the freight yard until the necessary repairs had been made to the track.

A GAS AND POWDER EXPLOSION occurred in the Big Four coal mine at North Fork, W. Va., on Sept. 17, and 17 men were imprisoned, with small chance of being recovered alive. The explosion was caused by an accumulation of gas catching fire from the lamp of a miner who was going to work, and this in turn firing six kegs of blasting powder that had been stored in the mines. The explosion knocked down all of the brattices for a quarter of a mile back toward the mine entrance, thus cutting off the air from the men imprisoned behind the debris.

A RESERVOIR EMBANKMENT FAILED AT UTICA, N. Y., on Sept. 17, doing considerable damage, but causing no loss of life. The reservoir belongs to the old portion of the works of the Consolidated Water Co., and was built by the Utica Water-Works Co. in 1873-74. It was a storage reservoir, built in a ravine or valley through which flows a small stream, sometimes called Starch Factory Creek. The reservoir was known as No. 3 or the Savage Reservoir, and had a capacity of 220,000,000 gallons. It appears that the embankment, which is variously stated as being 60 to 70 ft. high, had shown signs of failure for a number of days; in fact, that water poured over its top with increasing volume, so that messengers were ready to give warning when the failure occurred. The embankment gave way at 2.40 p. m., discharging a large volume of water down the ravine.

THE SECOND GREAT ERUPTION OF MT. PELEE has been reported on by Prof. Angelo Heilprin, who, since the May eruption, has been in Martinique in the interests of the National Geographic Society. We take the following abstract of his report from the New York "Times:"

The scene of destruction in the last eruption of Mont Pelée far surpasses in extent that of the eruption of May 8, when St. Pierre was destroyed, and includes the broad area lying between Macouba and Carbet, and involves Haute Tours de Bourdon, Basse Pointe, Morne Balai and Ajoupa Bouillon, where alone upward of 300 persons were killed, as well as Morne Rouge, with a death list of probably not less than 1,100 persons; Morne Capot and the heights somewhat this side of Fonds St. Denis, the blast, however, leaving the last-named place untouched. The destructive blast, instead of confining itself to a section or area, as was the case during the first eruption, was distributed radially, crossing the low summit of the volcano near the knob of Morne Jacob, and skipping zones between its rays. The danger from Mont Pelée is thus materially increased, and perhaps no position in the north of the island is absolutely safe. The government has judiciously ordered the evacuation of all points reached by a radius of about eight or ten miles from the crater. The recent phenomena were precisely like those of May 8, death resulting in most cases from contact with the terribly swift and hot blast, which burned and which suffocated. The sulphur emitted from the crater during the recent eruptions was comparatively insignificant, although it densely permeated the ash cloud which fell over Precheur. The electrical illuminations during the storm were wonderful, and greatly surpassed those of July 9. There was no barometric disturbance to indicate a coming eruption. The destruction of the several towns and localities was simultaneous, occurring at 9.10 in the evening.

SMOKE PREVENTION AT ST. LOUIS is to be aided by an ordinance passed by the municipal assembly and approved on Aug. 27. The ordinance is so brief that we reprint it in full, as follows:

Sec. 1. The emission or discharge into open air of dense smoke within the corporate limits of St. Louis is hereby declared to be a public nuisance.

Sec. 2. The owners, lessees, occupants, managers or agents of any steamboat, tug, or other water craft, or locomotive engine from which dense smoke is emitted or discharged within the corporate limits of St. Louis to the damage, injury, annoyance or detriment of any portion of the inhabitants of said city, or to the damage, injury, annoyance or detriment of any person or persons within said city, or to the damage, injury or detriment of any property within said city, shall be guilty of a misdemeanor and upon conviction thereof in any court of competent jurisdiction shall pay a fine of not less than $25 nor more than $100. And each and every day whereon such smoke shall be emitted or discharged shall constitute a separate offense; provided, however, that in any suit or proceeding under this ordinance, it shall be a good defense if the person charged with the violation thereof shall show to the satisfaction of the jury that there is no known practicable appliance, device, means or method by application of which to his steamboat, tug or other water craft or locomotive engine, the emission of the dense smoke complained of in the proceeding could have been prevented.

St. Louis is one of the few American cities that has a smoke inspection department.

PULVERIZED COAL FOR FUEL is to be used, reports state, at the pumping station of the Indianapolis Water Co. The pulverizing plant, now under construction, is claimed as the invention of Mr. L. K. Davis, of Indianapolis.

THE CONTRACT FOR THE RAPID TRANSIT Railway extension to Brooklyn has been awarded to the Rapid Transit Subway Co., which is now building the Manhattan portion of the Rapid Transit R. R. The work on the tunnel under the East River will be begun first, and before the middle of November.

THE SACCARDO VENTILATING SYSTEM as installed in the six-mile-long Giovi tunnel, north of Genoa, Switzerland, is said to work so perfectly that a block station has been established in the tunnel. Before the ventilating system was installed train men were asphyxiated in the tunnel. The Saccardo system was described in Engineering News of Aug. 31, 1899.

THE END OF THE MANNESMANN TUBE PROCESS in the United States is marked by the sale to a junk dealer of the Mannesmann rolling machines which were installed only a few years ago in a New England plant to roll brass and copper tubing. This plant was acquired by the American Brass Co. and has now been dismantled. As many of our readers may remember, the Mannesmann process was developed in Germany a dozen years or more ago, and was a most ingenious method of rolling a hollow tube from a solid bar in a single operation. It had a great success in Germany, and a factory was also built in England. In the United States samples of the Mannesmann product were exhibited at the International Engineering Congress in 1890, and also at the Chicago Exposition, but it was never taken up and made a commercial success in this country. In Germany it is now used only in the preliminary stages of seamless tube manufacture.

THE NEW YORK RAPID TRANSIT RAILWAY.*

IX.

Contract Section IV.

Contract Section IV. of the New York Rapid Transit Railway extends along Park Ave., from a point 100 ft. north of the center line of 33d St. to the center line of 41st St., passing by tunnel under the rocky elevation known locally as Murray Hill, which is one of the fine residence sections of the city. The subcon-

Fig. 41. View of Shaft Head Structure and Plant at South End of Section IV.

tractor for the section was the late Ira A. Shaler, M. Am. Soc. C. E.

MATERIALS PENETRATED.—Murray Hill, through which the tunnels pass, is formed by a surface outcrop of the mica-schist rock which underlies Manhattan Island. This rock is for the most part in compact strata dipping at about 45° from east to west, but at intervals an unstable stratum is encountered which when free to do so slides on the underlying stratum. Trouble from such a slide was had on Section III., as has already been mentioned, and on the section now being described a similar but far more disastrous slide was experienced, as is noted in detail further on.

DESCRIPTION OF STRUCTURE.—Contract Section IV., except for a short distance at the south end, is wholly in tunnel through the rock composing Murray Hill. From 34th St. to 41st St., a double-track tunnel occupies the center of Park Ave. This tunnel originally formed part of the Harlem Ry., but it has been occupied for many years by the double-track street railway line now forming a part of the Metropolitan Street Railway Co.'s system. Owing to the presence of this tunnel it was impossible to keep the

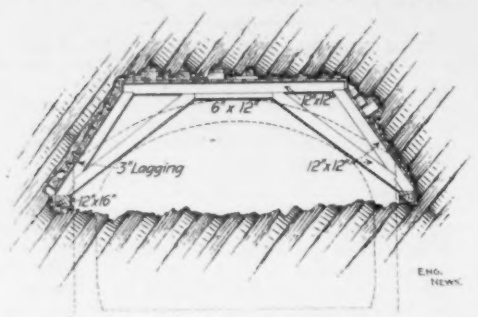


Fig. 43. Sketch Showing Method of Timbering Roof of East Tunnel at North End.

four tracks of the Rapid Transit line in one structure, since the rise of the arched roof would have destroyed the street car tunnel. It was, therefore, decided, as has been described in a preceding article, to separate the four tracks and carry them through two double-track tunnels and

*Previous articles in this series were published in Engineering News, from Jan. 30 to May 8, 1902.

to begin the separation at the south end of Section IV., so that by the time 34th St. was reached there would be a safe core of rock between the two subway tunnels and immediately beneath the street car tunnel above. The two subway tunnels are therefore located below and at the sides of the street railway tunnel. To secure as great a thickness of rock as possible between them and the street car tunnel their roof arches were designed with three centers, giving a flatter arc at the crown than would ordinarily be desirable in the material penetrated, which was a mica-schist rock of rather treacherous character. By means of the design described, however, there was secured between the two subway tunnels an intervening core of rock varying from 6 ft. to 40 ft. in thickness, and between the extrados of the subway tunnels and the foundations of the street car tunnel above a roof of rock from 3 ft. 9 ins. to 14 ft. thick. The cross-section selected for the tunnels had vertical side walls, and, as already stated, a three-centered roof arch; the interior dimensions being, width 25 ft. and height 16 ft. The distance apart of the two tunnels has already been indicated by specifying the width of the rock core between them. They were lined with concrete. During construction the tunnels were known as the East Tunnel and the West Tunnel, and as the methods of work differed, this nomenclature will be retained here.

METHODS OF WORK.—Each of the two tunnels was driven from a pair of shafts, one at each end. There were, therefore, two shafts at each end of the section, and they were located on opposite sides of the street with the open cut approach of the street car tunnel between them. To provide room for the shaft head plant the two shafts at each end of the section were fenced around and above them and over the open cut approach of the street car tunnel there was built a strong timber working platform. On this platform and within the covered space beneath it were located all the shaft head machines, the office, etc. Some of this plant served both shafts and of other parts there were separate installations for each shaft. The principal machines on each platform were two stiff-leg derricks, having their 25-ft. masts braced together and their booms 35 ft. long extending over the shafts. Each derrick was operated by a double-drum Lidgerwood hoisting engine, using compressed air from the main power plant, which is described later. Fig. 41 is a general view of the shaft head structure at 34th St. In this view the street car indicates quite clearly where the platform crosses the open cut tunnel approach. The excavation commanded by the large derrick in the foreground is a portion of the extreme north end of Section III.,

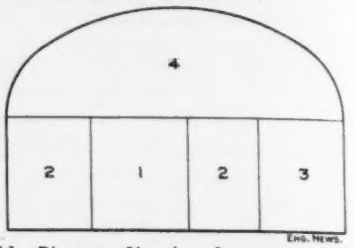


Fig. 42. Diagram Showing Sequence of Cuts in Driving East Tunnel Northward.

the building whose tower is seen in the far distance is the Grand Central Station.

The sinking of the shafts was of course the first work performed, and the shafts at the south end of the section were commenced first. The south shaft of the east tunnel was begun first on Sept. 17, 1900, and work was next commenced on the south shaft of the west tunnel on Oct. 15, 1900. These two shafts were each 30 ft. long and 20 ft. wide, and were located directly over the future tunnel section. The material penetrated was rock

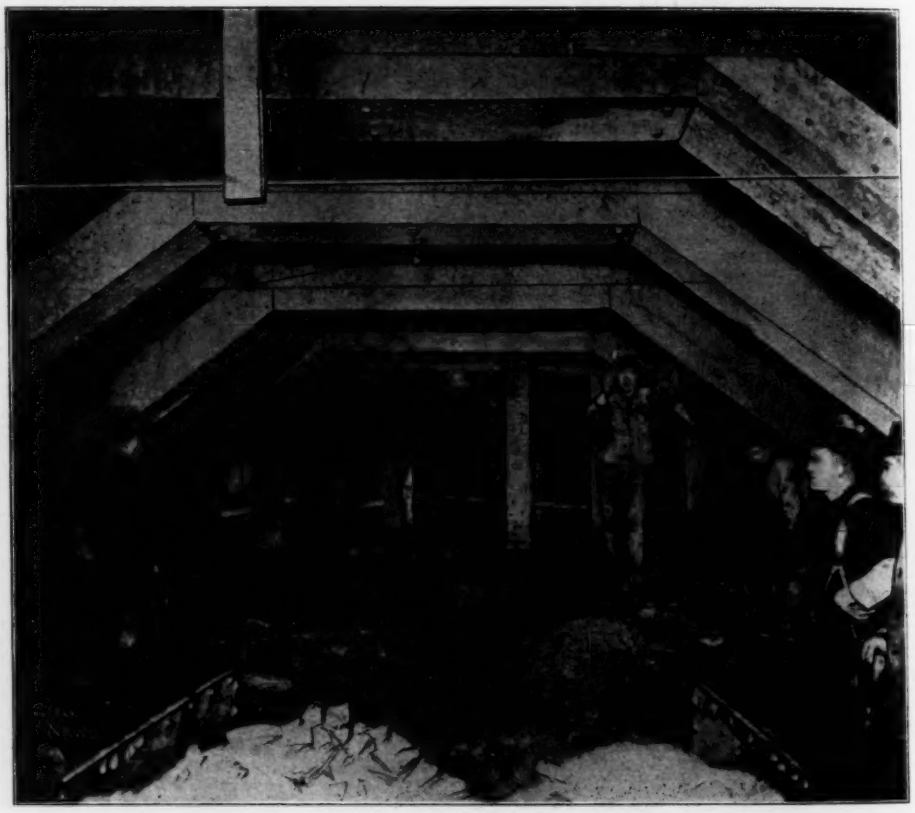


FIG. 44. VIEW OF ROOF TIMBERING OF EAST TUNNEL AT NORTH END.

so solid that no shaft timbering was required. The method of excavation was that usually adopted in rock shaft work, air drills and dynamite being used to break up the rock and the derricks already described to raise the spoil to the surface. The depth of the shaft to subgrade was 24 ft. in each case. The east tunnel shaft reached its final depth on Dec. 22, 1900, and the west tunnel shaft on Feb. 16, 1901. The north shaft for the west tunnel was begun Dec. 22, 1900, and for the east tunnel on March 22, 1901. These shafts were partly through earth which required timbering and they were smaller in section than the south shafts, but deeper, being, respectively, 38 ft. and 37.5 ft. deep. The west shaft was completed on Feb. 12, 1901, and the east shaft on April 1, 1901. The distance between shafts was 1,771 ft.

for the east tunnel and 1,824 ft. for the west tunnel.

Tunnel excavation was first begun from the south shaft of the west tunnel on Dec. 11 by driving a top heading, and from the south shaft of the east tunnel by driving a bottom drift. Work from the north shaft of the west tunnel was begun on Feb. 12, and from the north shaft of the east tunnel on April 16. To prevent confusion the construction of the east tunnel will be described first and then the construction of the west tunnel.

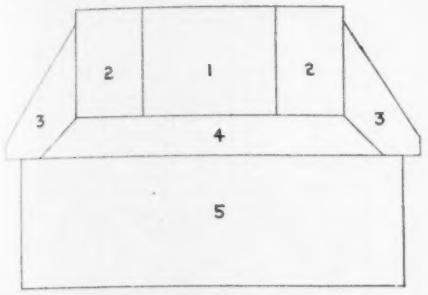


Fig. 45. Diagram Showing Sequence of Cuts in Driving East Tunnel Southward.

EAST TUNNEL.—The east tunnel was begun at the south end by a bottom drift about 10 ft. high and 8 ft. wide and 5 ft. deep, located as shown by Fig. 42. The drift was at once widened by removing the portions marked 2 and about 50 ft. in the rear of this widening part 3 was broken down and removed. Part 4 was broken down and removed about 50 ft. to the rear of part 3. The methods of drilling and blasting were as follows: In taking out the original drift No. 1 a wedge-shaped center cut was made, and this wedge was then enlarged to the full size of drift by drilling parallel holes. The succeeding sections 2, 3 and 4 were handled in a closely similar manner. The drills were mounted on columns and the holes were usually drilled about 7 ft. deep, starting with a diameter of 2¾ ins. and ending with a diameter of 1¾ ins. They were blasted with 40% dynamite in light charges and only a few holes were fired at a time, usually not more than three or four.

Working from the north end of the east tunnel was excavated by starting a top heading through rock, which proved to be soft, and divided by seams running in all directions. Permanent timber was found necessary, and the style of timber shown in Figs. 43 and 44, was adopted to suit the unusually flat roof and admit of the rapid shooting out of the bench. The timber is practically all placed outside of the concrete lining with the exception of the two interior braces, which were removed just ahead of the concrete arch, the load being then taken by a temporary center post until the arch had set hard enough to take the strain. The sequence of excavation is indicated by the diagram, Fig. 45. Part 1 was removed by a side cut, then lagged up at once by permanent lagging held up on temporary caps and posts; when part 1 was 8 or 10 ft. ahead, part 2 was blasted out by very light charges to avoid blowing out the posts supporting roof over part 1; part 2 was then lagged and supported on temporary timber as part 1 had been until the 20-ft. permanent cap could be put in on jack columns, and all the temporary timber removed. Part 3 was then blasted out by short holes drilled downward and outward approximately in the direction of the leg and the legs and braces put in. This timbering was required for a distance of 124 ft. southward from the shaft, but before this point was reached the rock stood much better, and parts 1 and 2 were run through under temporary posts, opening up the hard rock section to the south, the top heading of which was pushed ahead rapidly while the tedious widening and timbering continued near the shaft. Two tracks were maintained through the timber section branching out into three in the rock section until it became necessary to remove part 4 and place the long wall plates under the timber (previously supported on short footblocks) when one track was taken up at a time in short sections and the cars switched around the place. The top heading having at this time penetrated 550 ft. southward was discontinued, the shaft sunk to subgrade, and all attention turned to taking out the bench, or part 5, in the diagram, Fig 45. It was found necessary to underpin the wall plates on the east side of the tunnel owing to the tendency of the strata of rock to slide out on that side. The bench was removed by drilling vertical holes with drills mounted on tripods. Parts 1, 2 and 3 were drilled by machines mounted on columns. Large voids above the lagging were filled with tightly-wedged blocking and stone, and grout was forced in through pipes after concreting to fill up all remaining spaces.

The method of hauling away the excavated material was similar at the two ends of the tunnel. At the south end three parallel tracks were laid on the floor of the tunnel and extended to the faces of the advance drifts. On these tracks small flat cars were run and carried boxes 5 ft. square and 15 ins. deep fitted with three lifting rings and chains. When filled the cars were run to the bottom of the shaft, the boxes were hoisted by the derrick at the shaft head and the spoil was dumped into an elevated storage bin of about 300 cu. yds. capacity. This storage bin was elevated 8 ft. above the street so that wagons could be driven under it and take loads of spoil by means of chutes. In excavating parts 1, 2 and 3, Fig. 42, the broken rock was loaded onto the cars by hand. For excavating part 4 a traveling platform, indicated by Fig. 46, was used. On this platform were mounted the column drills, temporary struts being inserted underneath to take their thrust. Upon blasting the platform was moved back allowing the blasted rock to fall to the floor of the tunnel, whence it was loaded into boxes on the cars. The roof timbering shown by this view was used for only a short distance. At the north end of the tunnel three parallel tracks were first laid on the heading floor, while the heading and timber work was proceeding, then torn up and relaid at the lower level for handling the material from part 5. The cars were run to the bottom of the north shaft, and the boxes hoisted out and discharged into a storage bin exactly as at the south end.

FIG. 46. VIEW SHOWING ROLLING PLATFORM USED FOR EXCAVATING TOP HEADING 4 IN FIG. 42.

WEST TUNNEL.—The west tunnel was begun at the south end by driving first a top heading and then enlarging the section by the sequence of cuts shown by Fig. 47. Parts 1 and 2 were kept close together in excavation with part 3 about 50 ft. to the rear of them and part 4 about 50 ft. behind part 3. The bench 4 was removed by drilling vertical holes, but the other parts were taken out by the center cut method used on the east tunnel and already described. The spoil was removed in cars like those already described for the east tunnel, which run on three parallel tracks on the tunnel bottom. These tracks extended to the face of the bench, or part 4; the spoil from the upper cuts had to be wheeled in barrows from 50 to 100 ft. to the ends of the tracks.

To enable this wheeling to be done without hindrance by the work on the bench face short temporary platforms were carried out from the top of the bench so as to clear the bench spoil bank. The supports for this wheeling platform were simple and efficient and so novel as to merit particular mention. They consisted, first, of a transverse girder formed by telescoping a 2½-in. gas pipe into a 3½-in. gas pipe about 24 ft. long, thus making an extension beam, the ends of which could be inserted in pockets cut at the proper heights in the side walls. When set in position the telescoping pipes were prevented from closing together by a collar sliding on the smaller pipe and provided with a set screw by which it could be clamped against the end of the larger pipe. Telescoping posts or struts of similar construction were inserted under the long transverse pipe to give it support at intermediate points. As will be readily understood, one end of the wheeling platform was set on the transverse pipe and the other end on the top of the bench; the barrows were wheeled to the outer end and dumped into the boxes of the cars standing on the tracks below.

The foregoing describes the work from the south end of the west tunnel by the top heading method of excavation. This method was continued only for a short distance when work was stopped on cuts 1, 2 and 3, Fig. 47; until the bench cut 4 had caught up with them and then work was continued by the bottom drift method indicated by Fig. 42.

Work at the north end of the west tunnel was begun by the top heading method illustrated by Fig. 45, and was carried on as already described for the east tunnel so long as soft rock was encountered, which was for a distance of about 115 ft. south from the shaft. When the rock became firm, however, the contractor changed to the bottom drift method illustrated by Fig. 42, and described in connection with the east tunnel work.

BLASTING.—The blasting of the rock on the tunnels of Section IV. was carried on under unusually various conditions. As previously stated,

Park Ave. is bordered on both sides by fine residences, hotels and other structures whose occupants made necessary extreme care not to disturb or injure persons or property. At the beginning of work considerable damage was done to the windows of buildings surrounding the shafts at 34th St., despite the fact that the dynamite charges used were very light and that only three or four holes were fired at a time. The rush of air from the shafts was the cause of the damage. To remedy this the shaft mouth was covered with heavy timbers during blasts, the idea being to break up and deflect the air waves, and this reduced the trouble somewhat. Later on it was decided to use heavier charges in deeper holes with the idea that the energy of the dynamite would be largely expended in the rock and not in the air. This change also helped the trouble. From first to last, however, the contractor was deluged with complaints of the noise and shocks of the blasts, which no reasonable reduction in

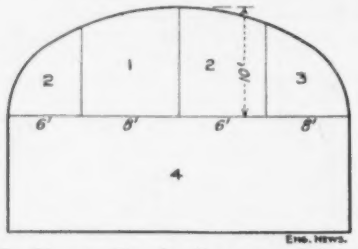


Fig. 47. Diagram Showing Sequence of Cuts in Excavating West Tunnel Northward.

the blasting charges seemed able to obviate. As already indicated, the conditions finally settled down to the use of small charges of 40% dynamite placed in numerous holes, with a maximum burden of about 2 ft. on each hole, and to the firing of not more than four holes at a time.

VENTILATION.—The ventilation of the tunnels caused very little trouble. In cool weather the natural draft of the shafts with the air discharged from the drills served to keep the atmosphere of the workings wholesome. In warm weather, however, artificial means were necessary to clear the workings of foul air, particularly after blasting. These comprised at each end a 4-ft. American exhaust fan drawing air from a 12-in. riveted galvanized iron pipe extending to the working faces.

CONCRETE LINING.—Both tunnels were lined with concrete, the sectional profile of which is fairly indicated by Fig. 43. To manufacture this concrete and put it in place was an important task. Beginning at the shafts the lining was carried north from one end and south from the opposite end of the section, and a different method of work was adopted at each end. The method of work from the south end will be described first.

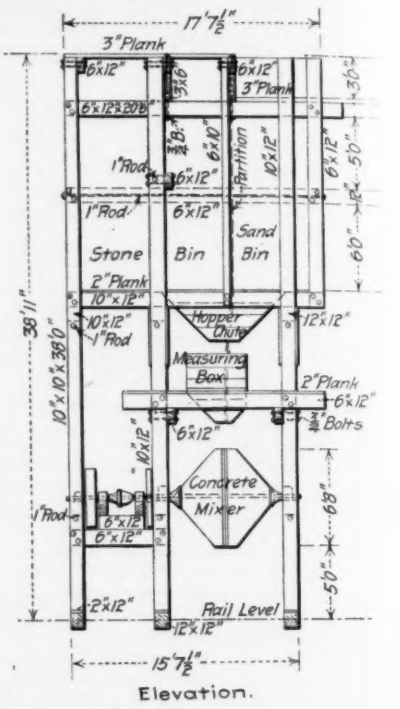
The plant for manufacturing concrete at the south end is quite elaborate. The shaft head platform, which has been described, was continued southward over Park Ave. to 33d St., into which it turned eastward for a short distance. At the extreme east end of this platform there was located a crusher plant, with the necessary bins for raw stone and crushed stone. Along the platform there was laid a double track push car line, with frequent crossovers and switches, which connected the crusher plant with the shaft head platform. Stone was hoisted from the shafts in steel skips, which were set on push cars and run to the crusher plant raw stone bin and dumped. The car then proceeded to the chutes from the crushed stone bin, were loaded, and then proceeded back to the shaft head platform, where their loads were discharged into the crushed stone bin of the mixer plant. After dumping the skips were sent down the shaft to be again loaded. The handling of the skips onto and off the cars and through the shaft were done by the fixed derricks, already described.

The mixer plant was located at the northwest corner of the shaft head platform, where a special timber framework was built for it. A front elevation and plan of this framework is shown by Fig. 48. As will be seen, the top portion of this framework holds a bin divided by a partition into two compartments. The top of this bin was level with the top of the shaft head platform, and also with the street surface at its west side. One compartment of the bin was for crushed stone, which it received by car from the crusher plant, as already described. The other compartment was for sand, which was dumped directly into it from wagons at the street surface. The bin terminated in a hopper chute, the opening of which centered over a measuring box immediately beneath. It will be noted that the bin partition was made continuous through the hopper bottom and the measuring box, thus keeping the stone and sand separate in the measuring box. A sliding door, operated by a lever, in the bottom of each bin compartment was provided to admit the stone and sand into the hopper and measuring box, marks on the sides of the latter showing when the proper amounts had been admitted. The cement was brought in bags to the platform surrounding the measuring box and the proper amount was deposited on the top of the broken stone. Beneath the measuring box was a cubical mixer operated by an engine located at one side on the same level. A movable canvas chute directed the material from the measuring box into the mixer. The mixer itself discharged its contents into skips setting on cars which were run beneath it. These cars were then taken along the tunnel bottom to the plant, where the lining was being built.

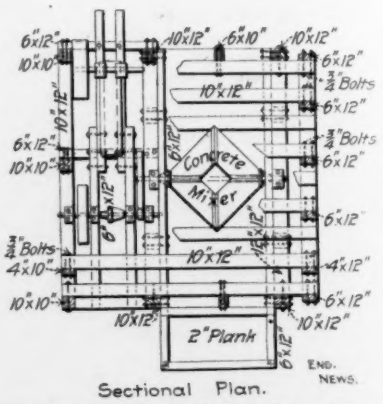
The construction of the lining was accomplished by means of a rather elaborate plant of traveling platforms. First of all the footing courses of the sidewalls were laid. As the footing courses project inward about 18 ins. from the faces of the finished sidewalls, it was possible to lay a track rail on their top inner edges on each side of the tunnel. These track rails carried the traveling platforms. There were three of these platforms; the forward one being used for building the sidewalls, the center one for carrying a derrick, and the last one for building the roof arch.

The sidewall platform is shown in part front elevation and part side elevation by Fig. 49, which explains its construction quite clearly. As will be seen, the platform was mounted on six wheels, three on each side. On each side there was mounted an adjustable lagging curved to conform to the inside profile of the sidewall. In operation this platform was run to the point where the sidewalls were to be constructed and the lagging was adjusted to position and fastened. Skips of concrete were then hoisted onto its top and their contents shoveled into the space between the lagging and the wall of the excavation, and there rammed in place, until the finished concrete had reached the top of the lagging. When the concrete had set the wedges holding the lagging in place were loosened and the platform moved ahead and adjusted for building a new section of wall.

Behind the sidewall platform came the derrick platform. This was of the same general construction, except that the lagging on the sides was omitted. Briefly described, the derrick platform was 22½ ft. wide between centers of outside wheels and was 18 ft. long over all. Transversely, it had three bays, two of which were floored over and one left without flooring to allow passage for the concrete skips to and from the cars on the tunnel floor beneath. At the center of



Elevation.



Sectional Plan.

Fig. 48. General Plan and Elevation of Concrete Mixing Plant at 34th St. Shafts.

the floored area there was mounted a derrick to handle the skips. In operation the derrick platform came between the sidewall platform ahead and the roof arch platform behind. Cars coming from the concrete mixer ran beneath the opening and their skips were hoisted by the derrick and placed as desired on either cars running on the sidewall platform or others running on the roof arch platform.

The construction of the roof arch platform is shown by Fig. 50. It was practically the same as the sidewall platform, with the addition of roof arch centers at each bent, on which lagging could be placed. Referring to the end elevation, it may be noted that the tops of the completed sidewalls came to about the level B, while the roof lagging began at the level A. This left an opening A B, in which small sector-like forms had to be used to build the concrete against. The mode of procedure was to erect the forms for the space A B, and to shovel the concrete from the skips on the platform cars behind them and run it into place. The roof lagging was then placed a part at a time from the haunches upward, and the concrete filled and rammed behind it. As long as the height of throw was not too great the shoveling was done directly from the skips, but as the height of throw required became excessive, a narrow platform was built, as indicated at C D, or

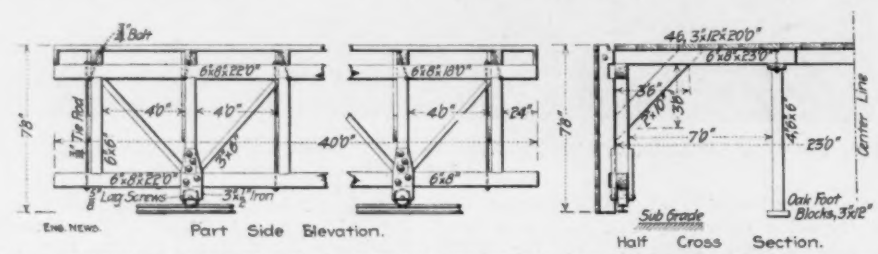


FIG. 49. GENERAL ELEVATIONS OF TRAVELING FORM FOR BUILDING CONCRETE SIDEWALLS.

which the concrete was shoveled from the skips and from which it was again shoveled behind the lagging.

The lining was built from the haunches upward until the two sides approached within a distance of about 5 ft. from each other at the crown. This 5-ft. crown strip or key was built by working from the rear end toward the forward end of the platform. Fig. 51 is a view above the centers, showing the haunch portions brought up to the points where the keying operation was to begin. While placing the concrete for the roof arch the platform was jacked up off the track rails, as is indicated by the end elevation, Fig. 50. It will also be noted that all three platforms are elevated so as to clear the construction tracks and permit the free circulation of spoil and material cars beneath them.

The method of work adopted at the north end was somewhat more simple than that just described. In the tunnel heading just north of the shaft there was erected a platform carrying a crusher plant. Broken stone from this crusher dropped into shallow bins and thence into skips which were hoisted by the derrick to the shaft head platform. There the stone, sand and cement was fed into a gravity mixer whose lower end was just enough above the tunnel floor to permit a push car carrying a skip to run underneath and be filled with concrete. For laying the concrete a stationary form was used consisting of a framework much similar to that shown by Fig. 52, which was lagged on the sides and top. This centering was not mounted on wheels, but was knocked down and set up anew for each piece of lining. Fig. 52 shows a section of completed lining laid by the form just described; the view shows also the 41st St. shaft in the distance and the lower end of the gravity concrete mixer. All voids above the concrete roof arch were packed with timber and stone and grout was then injected into the interstices.

PROGRESS OF WORK.—In commenting upon the progress of excavation on the tunnels of Section IV., it is well to note first the changes made in the methods of excavation as the work progressed. With few exceptions American rock tunnels have been excavated by driving a center top heading, enlarging this to clear the upper half of the tunnel, and then removing the bench in practically one cut. It will be observed from the preceding description that the north ends of both tunnels and the south end of the west tunnel were begun by top heading methods, and that with the exception of the north end of the east tunnel these were changed to the bottom drift method as soon as sound rock was being penetrated. The reason for this change is stated by Chief Engineer Parsons to have been that a few months' comparative trial demonstrated the bottom drift method to be the more economical. No reasons have been given by the engineers why this was the case, but the opinion may be ventured that it was due chiefly first to the greater economy of haulage, and second, to the necessity of using small blasts. In the bottom drift method it was possible to carry the spoil tracks to the very face of the work on every cut and only one handling of the stone was, therefore, required; in the top heading methods all the spoil from the several cuts above the final bench had to be wheeled in barrows from 50 to 100 ft., and reloaded into the spoil cars. As regards the blasting, it is one of the chief advantages of the large top heading and single bench method that heavy charges and a large number of holes can be fired in one blast, and in this work that advantage was of no avail because the local conditions made it impossible either to use heavy charges or to fire more than four holes at once.

At the busiest period of the work about 600 men were employed on the two tunnels. These men worked in three 8-hour shifts, using electric lights. Extreme care was exercised in the organization of the working force. The rate of progress varied from month to month, as shown by the accompanying table.

	Advance north'ly		Advance south'ly	
	E. head, 34th St., ft.	W. head, 34th St., ft.	E. head, 41st St., ft.	W. head, 41st St., ft.
December, 1900....	14	24	..	..
January, 1901.....	69	57	..	..
February.....	62	69	..	12
March.....	92	73	..	17
April.....	77	51	30	18
May.....	40	36	17	23
June.....	68	74	43	68
July.....	79	52	59	70
August.....	63	93	91	70
September.....	82	69	66	..
October.....	98	107	93	..
November.....	99	97	95	57
December.....	111	90	56	126
Totals.....	954	892	550	461

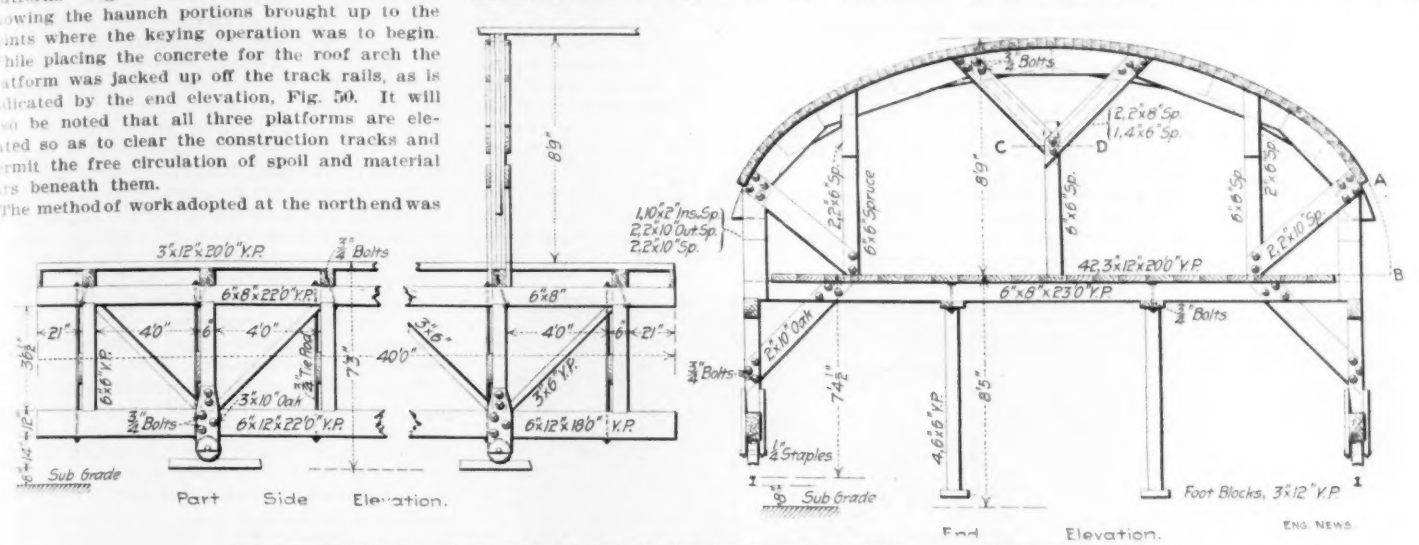


FIG. 50. GENERAL ELEVATIONS OF TRAVELING FORM FOR BUILDING CONCRETE ROOF ARCH.

PLANT.—The plant used by the contractors in constructing Section IV. of the subway comprised a central power plant located some distance from the work, and what may be called the field plant on the work. The central power plant was located on 42d St., near the East River, and furnished power for the work on both Section IV. and the succeeding Section V-a. The buildings consisted of an engine room, 63 ft. × 30 ft. 4 ins., and a boiler room, 42 ft. × 28 ft. 3 ins. In the engine room was located one Rand-Corliss air compressor, 22 × 40 × 48 ins., having a capacity of 5,000 cu. ft. of free air per minute, and in the boiler room there were two 200-HP. water tube boilers. There were besides the necessary equipment of feed water pump, air and condenser pump, etc. The compressor discharged into a 20 × 5½-ft. riveted steel receiver through a 7-in. pipe, and from the receiver the air was carried by a 10-in. pipe 3,277 ft. to the corner of Park Ave. and 41st St., whence an 8-in. pipe ran south along Park Ave. From this 8-in. track 3-in. branches led to the four headings of the work.

The field plant operated by this central compressor plant comprised five 7 × 10-in. double-cylinder, double-drum hoisting engines, thirty 3½-in. drills, two blacksmiths' fires, two 4 × 4 × 6-in. Cameron pumps and three Dake rotary engines. The field plant consisted, besides these items, of a stone crusher, shaft derricks, spoil tracks, storage bins and minor constructions and machines. The spoil tracks and the storage bins deserve further mention. The spoil tracks consisted of lengths of fixed tracks laid from the shafts

FIG. 51. VIEW SHOWING TOP OF TRAVELING CENTER AND ARCH HAUNCHES COMPLETED READY FOR KEY.

to within about 100 ft. of the working faces, and of portable track sections for the remainder of their length to the faces. The portable track sections were in 24-ft. and 12-ft. lengths, and consisted of 20-lb. rails spiked to 2 × 10-in. cross-ties 4 ft. long, spaced 6 ft. apart. The rail spikes penetrated the ties far enough to allow for a nut on their projecting ends, which were threaded for that purpose. The sections were connected by 10 × ⅝-in. steel plates bent to slip over the base of the rails and connect the adjacent rail ends like a split sleeve. No butts or fish plates were used with this connection. The purpose of these portable track sections was to enable the track to be taken out of harm's way some distance back of the working face during blasts.

The storage bins were two in number, and were located at the two ends of the tunnel to hold the spoil from the excavation until it could be hauled away. Each bin was divided into three compartments having an aggregate storage capacity of about 350 cu. yds. It consisted of a rectangular box having a floor of 3-in. plank and sides 10 ft. high of vertical sheathing attached to posts well braced together, which was mounted about 8 ft. above the ground on three rows of columns braced together parallel with the curbs. The elevated position of the bin enabled teams to be driven underneath it on each side of the center row of columns. The end compartments of the bin were used to hold stone. In the outer walls of these compartments there were flap doors through which the stone could be discharged onto a platform alongside, and thence through holes 2 ft. square into wagons beneath. The middle compartment was designed to hold dirt and fine stuff and had slide doors in its bottom capable of being opened and closed by a windlass, and through which the spoil could be discharged into wagons. It was the practice to store all the material excavated at night, and to do all hauling away by day. The dirt and fine stuff was hauled to scows and towed to sea and dumped; the rock was used for crushed stone and disposed of for dock work, foundations, etc.

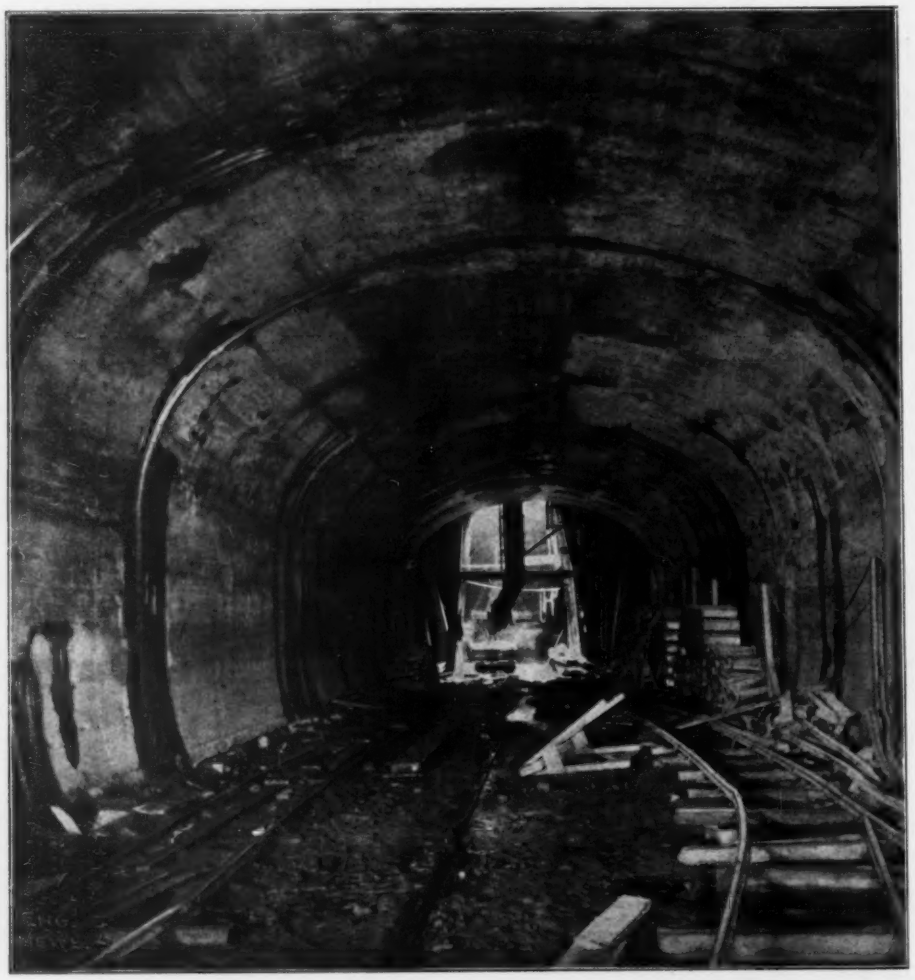


FIG. 52. VIEW SHOWING COMPLETED CONCRETE LINING SOUTH OF 41ST ST. SHAFT OF WEST TUNNEL.

ACCIDENTS.—The work on Section IV. was distinguished by a number of unfortunate accidents. On Jan. 27, 1902, an accidental explosion of a quantity of dynamite stored in a frame shanty located at the north end of the section resulted in the death of a number of persons and widespread damage to the adjoining buildings. On one side of the avenue opposite the shaft where the dynamite was stored is the Murray Hill Hotel, and on the other side is the Manhattan Eye and Ear Hospital; looking down Park Ave. and fronting on 42d St., a little over a block away, is the Grand Central Station of the New York Central & Hudson River R. R. On the same side of the avenue as the Eye and Ear Hospital, and between 41st and 42d streets, is the Grand Union Hotel. To the south of the Murray Hill Hotel and the hospital both sides of the avenue are bordered by typical brownstone New York residences. The principal damage was done to the buildings which have been named, and consisted chiefly in the general destruction of window glass, plaster walls and ceilings, furniture, pictures and pottery. The damage done to the tunnel structure was insignificant. No definite knowledge was obtained of the amount of dynamite which exploded or of the exact cause of the explosion.

A second accident resulting in less widespread but more serious local damage was a rock slide on March 21, 1902. The slide occurred between 37th and 38th streets, and in the east tunnel. At this date only the bottom cuts 1, 2 and 3, Fig. 41, had been excavated at this point. They had penetrated the mica-schist strata, dipping about 45° from east to west, and had shown no soft or unsound rock. None but light trimming blasts were being fired. The progress of the accident was as follows: During the night of March 19, about 65 ft. in length of the east wall and the east part of the roof of the drift slid down into the drift, partly filling it. An examination of the slide showed that a wedge-shaped stratum broke at the bottom had slipped down between the adjoining strata. The slip did not reach the street surface; that is, the fallen rock had broken away from the rock above, leaving a cavity.

Immediately after this first disturbance of the rock the subcontractor concentrated his force and began shoring the undisturbed roof of the drift. This work was continued during the following day, March 20. Despite this shoring a wedge-shaped crack parallel to the drift and near the west edge of its roof began to open. This crack extended up into the rock at an inclination of about 45°, and constantly increased in width until the morning of March 21, when the east half of the roof of the drift fell in, crushing the supporting timbers. The slide extended this time to the street surface and undermined the front walls of the adjoining houses, causing them to fall in part. Steps were taken at once to shore up the house walls and prevent further falls of rock by discontinuing work and by all other means which suggested themselves. The total length of tunnel affected by the rock slide was about 65 ft.

The accident caused widespread alarm among the adjoining property-owners, and they began at once to make a vigorous campaign to secure such measures of caution on the part of the tunnel workers as would prevent a reoccurrence of a similar accident. The Rapid Transit Commission, and the general contractor cordially co-operating, a commission of experts was appointed to investigate the accident and to suggest the best means for continuing the work. This commission consisted of Mr. V. G. Bogue, M. Am. Soc. C. E.; Mr. A. L. Webster, Assoc. M. Am. Soc. C. E., appointed by the property-owners; Mr. Theodore Cooper, M. Am. Soc. C. E., appointed by the commission; and Mr. Wm. Barclay Parsons and Mr. Geo. S. Rice, M's. Am. Soc. C. E., of the commission's staff. The report of this commission was as follows:

WEST TUNNEL.—In our opinion, work can safely be resumed in the west tunnel under Park Ave. by beginning the blasting only at the north and south end of the unfinished portions of the roof lying between 37th and 40th Sts. Moderate charges to be used throughout, especially moderate at the north end for the first 50 ft., and as long as and whenever there is any indication of defective rock. The Rapid Transit Commission to make, in advance of the excavation, diamond drill borings from the surface to within at least 6 ft. of the neat line at the tunnel, provided the rock is sound or deeper, if necessary, to show how much solid rock there is above the neat line of the tunnel. Holes to be placed 75 ft. apart, and as near as practicable following the center line of the tunnel. The masonry lining and arching to be kept as close as possible to the face of each excavation.

EAST TUNNEL.—No blasting to be done between Station 164 plus 50, near 37th St., and Station 170, about 40 ft. north of 39th St., until the arching is completed up to the bench at the north end. At least one diamond drill hole to be driven north of 38th St. on the east side from the surface outside of the neat line of the tunnel, and in addition ten drill holes to be driven on each side from the top of the bench, between Stations 168 and 170, diagonally outward to the sub-grade, to determine the character of the rock. Before the work is allowed to proceed, if there are indications of bad rock, extra holes are to be put in to determine the quality of the rock. If this investigation indicates sufficient rock of suitable quality, the work of removing the same south to the center line of 38th St. may proceed under the conditions and with the same precautions as indicated above for the west tunnel. The whole of the section of the east tunnel from which the roof has not yet been removed to be thoroughly timbered and braced during the progress of the work. Further consideration of the section between Stations 164 plus 50 and the center line of 38th St. shall be postponed until the investigations as to the character of the rock shall be completed.

The work was continued on the lines suggested.

The final accident of the series occurred on June 17, when the fall of a large piece of rock from the roof of the tunnel near 39th St., struck and killed the subcontractor, Mr. Ira A. Shaler, who was making a journey of inspection through the work.

ENGINEERS AND CONTRACTORS.—The engineers in charge of Section IV. were Mr. Albert Carr, Division Engineer for the Rapid Transit Commission; Mr. E. C. Moore, Division Engineer for the General Contractor; and Mr. Charles E. Fraser and Mr. J. C. Hilton, engineers for the subcontractor.

THE NEW YORK STATE TOPOGRAPHICAL SURVEY, carried on by the U. S. Geological Survey, has made good progress this season. Eight parties have been in the field engaged in mapping work and about 450 sq. miles have been mapped. Three other parties have been engaged in primary triangulation and traverse work.

ANNUAL MEETING OF THE INTERNATIONAL MINING CONGRESS.

We gave last week in our Supplement a brief account of the recent convention of this organization, which was held at Butte, Montana, during the week ending Sept. 6, and was attended by about 500 persons. From our own representative in attendance at the meeting a fuller report is now available.

The important feature of this year's convention was the reorganization of the body under the name American Mining Congress on the basis given below. For several years the more thoughtful members and friends of this movement have realized the need of a closer and more business-like organization, with purposes broader and less political in their nature; but they have not heretofore been able to carry their ideas into operation. This year a more determined effort was made, and although at one time it looked as though the movement might disrupt the congress, in the end it proved successful, and at the final adjournment the delegates were almost unanimously in favor of the new organization. The general basis of the new organization can be seen from the following extracts from the constitution adopted at this meeting:

Sec. 2. That the object of this association shall be the promotion in every possible way of the mining industry.

Sec. 3. That the officers of this association shall be a president, three vice-presidents, a secretary, a treasurer and an executive committee, to consist of the above officers and three members to be annually elected by the congress.

Sec. 4. That the following additional committees be elected by the executive committee:

An advisory committee, to be composed of one member from each state; a committee on legislation, of five members; a committee on membership, of seven members; a committee on transportation, of five members; a committee on finance, of five members; a committee on programme, of five members, to which committee each paper to be presented before any meeting of the association shall be submitted for approval in advance of said meeting.

Sec. 5. Membership.—Any person actively associated with mining, who, after his application has been approved by the committee on membership, shall pay an initiation fee of five dollars ($5.00), may become an active member of this association, and thereafter he shall pay in advance an annual fee of two dollars ($2.00), and shall vote and enjoy all other duties usual to members.

Any person actively associated with mining, with the approval of the committee on membership, shall, upon the payment of a fee of one dollar ($1) per annum, become an associate member of this association, and shall be entitled to attend the sessions of the congress and participate in its deliberations, but shall not be entitled to vote or to hold office.

Delegates.—A chief executive of any country, state or territory may appoint as delegates to any annual session of this congress fifteen (15) persons, actively associated with mining; and the mayors of cities or towns, boards of trade, boards of county commissioners, scientific associations, miners' organizations, mining bureaus, chambers of commerce, and such other business organizations as may from time to time be designated by the executive committee, may each appoint three such delegates, and each such delegate attending and properly accredited shall be entitled to participate in the deliberations of the congress.

Resolutions were adopted asking the various states to make exhibits of their mineral resources at the World's Fair at St. Louis; asking the Federal Congress to establish a Cabinet Department of Mines and Mining, and to provide for the establishment of mining schools in each state and territory out of the proceeds of the sale of public lands.

One of the most interesting papers presented at the convention was by Mr. Waldemar Lindgren, of the United States Geological Survey. We reprint portions of it as follows:

The Gold Production of North America; Its Geological Derivation and Probable Future.

Practically the whole of the gold output is derived from fissure veins or from deposits which possess close relationship to fissure veins. Gold-bearing fissure veins are in most cases accompanied by placers, which are only the result of nature's crushing, concentrating and refining. Fissure veins are formed chiefly by ascending hot waters. From this we conclude that gold has been brought up from lower levels of the earth's crust.

From the time of discovery up to 1900 the United States have produced $2,360,000,000, Mexico at least $181,000,000, and probably twice as much, and British North America $142,000,000, making a grand total of $2,683,000,000. This great product is divided among primary veins of pre-Cambrian, Cretaceous and post-Miocene age. These are the grand divisions, but when it comes to details it will soon be seen that it is a difficult matter to separate the two last groups. In fact, from the beginning of the Trias down to the present times great eruptions have followed each other on the Pacific coast, and each of these was probably accompanied by more or less extensive gold deposits.

PRE-CAMBRIAN DEPOSITS.

About 100 years ago gold was discovered in the slates of the Appalachian mountain region; in Georgia, and in the Carolinas; in Tennessee, Maryland and Virginia; yes, even further north. These are placers and gold-quartz veins with free gold and auriferous sulphides, and much of the gold can usually be extracted by amalgamation. Poorer deposits of the same kind have been found up to the Canadian line, and north of this, richer gold veins occur in Quebec, Ontario and Nova Scotia. During the last century this belt produced $47,000,000 in the United States, and $17,000,000 in Canada, chiefly in Nova Scotia, and during the last ten years the southern states have pretty regularly yielded $300,000, and from $500,000 to $1,000,000 in Canada. The yield is steady and can be relied upon for many years to come.

Most of these veins were evidently formed before the Cambrian period; they are thus very ancient and existed long before the great forests of the Carboniferous had been transformed into coal beds.

The old pre-Cambrian schists of the Black Hills in South Dakota contain fissure veins and seam belts of free milling gold ores at places where erosion has removed the overlying Cambrian sandstones. These deposits are worked on a large scale, though the ores are poor and have yielded since discovery in 1877 about $80,000,000, and produce annually $3,000,000 or $4,000,000 from this source. Here again the yield is said to be assured for many years, and this sustains the statements made above about pre-Cambrian deposits.

Altogether, then, the pre-Cambrian deposits have given us, since discovery, $144,000,000. One more thing should be said about this class. In most cases extensive erosion has taken place since these veins were formed, and the surface of the land at the time of their formation must in some cases, at least, have been thousands of feet above the level at which they are worked at present. They are the "roots" rather than the outcrops of veins, and this inspires belief in their permanency. For a long time after the pre-Cambrian veins had been formed no further mineralizing action occurred. We do not know of any Silurian, Devonian or Carboniferous gold deposits in North America. But in the Mesozoic age the great eruptions of the Cordilleran region began and the Cretaceous period was especially remarkable for the many mineral deposits formed throughout that region.

CRETACEOUS DEPOSITS.

The most important gold belt in North America is that stretching along the Pacific coast. It is throughout characterized by free-milling quartz ores with auriferous sulphides. A great erosion has taken place since it was formed, and here, too, as in the pre-Cambrian deposits, we have to deal with the lower part of veins, the upper parts having generally been removed to the extent of thousands of feet in many places.

Beginning in Baja California, Mexico, a hundred miles or more below the boundary lines, this great belt continues through San Diego, Los Angeles and Kern counties up through the central part of California, where it is developed in great strength; then up to northern California, southwestern and northeastern Oregon. In the latter state it is modified by the appearance of many silver-gold deposits and veins carrying auriferous sulphides without free gold. Covered for a distance by the lava flows of the Cascades, it again appears in southern British Columbia, on Vancouver Island, among other places. Strong development is again attained in the Cariboo district in Central British Columbia, and it continues through Omineca, Cassair and Atlin districts to the Klondike region, and thence bending westward, follows the Yukon to the western end of the continent at Nome on the Seward peninsula.

Throughout this immense stretch of country the veins are accompanied by great development of placers; they are, indeed, characteristic of this class of gold veins.

California alone has yielded $1,300,000,000 from this belt, Oregon $55,000,000, British Columbia and Northwest Territory $120,000,000, Alaska $31,000,000, a total of over $1,400,000,000. During 1900 the belt yielded $50,000,000, of which one-half came from British Columbia and the Yukon. This represents a great increase compared with the figures of ten years ago, and the question is whether this increase will be maintained. At least $27,000,000 were obtained from the new placers on the Yukon and in Alaska.

If no further great discoveries are made in this region, our knowledge of placers forces us to the belief that this last figure will rapidly decrease. Even if the placers gradually decline in the northernmost territories, it is believed that increased quartz mining will to some degree compensate for this; but the quartz mines have usually in the older districts yielded less than the corresponding placers. California's output will doubtless be maintained at about the present figure for many years.

Besides the Pacific gold belt, there is a broad zone in the central and eastern part of the Cordilleran region which contain an abundance of Mesozoic gold deposits.

This broad zone begins in Mexico in the Pacific states of Sonora and Sinaloa. Prominent veins are those of the Congress, Fortuna and Gold King mines.

Similar deposits appear again in Nevada and Utah.

In Utah the principal gold mines are those of the Mercur district, in which ores suited to the cyanide process occur in limestone close to intrusive sheets of porphyry. These yielded over $2,000,000 in 1900. Most of the remaining amount credited to Utah is derived from gold-bearing ores of the smelting class. In Colorado the most important Cretaceous gold deposits are those of Leadville. Here, again, the ores occur in Carboniferous sediments near porphyry contacts and the gold production, small until a few years ago, reached $2,700,000 in 1900.

In Idaho and Montana the late Mesozoic veins are developed on a large scale.

Montana has probably produced about $175,000,000 of gold since discovery, and the output in 1900 was $4,700,000.

In this great chain of deposits the gold production is closely associated with the silver and copper industry. The effect is perhaps to make it more stable. According to past experience, no wonderful increase of production may be expected, but rather perhaps a steady maintenance and perhaps a gradual increase. Placer mining, with its dwindling tendency, is almost eliminated in the consideration of this belt.

TERTIARY DEPOSITS.

A fourth and last class of veins which produce gold are those of Tertiary, mostly post-Miocene age, and which usually are found cutting heavy andesite flows, more rarely rhyolite and basalt, in regions of intense volcanic activity.

They are often characterized by great richness, the word bonanza being first coined to represent their big ore shoots. Aside from enriching surface processes, the greatest values appear to occur not far from the surface. The gold is nearly always in such peculiarly fine distribution that extensive and rich placers are rarely formed from them, contrasting in this respect against conditions in the Pacific gold belt. Many of them, in districts of great erosion, show that the values continue in depth, but perhaps less rich than those parts formed nearer to the original surface. For in this class we evidently have to do with the part of the vein which was not far from the original surface at the time of ore deposition. In some cases the ores can be proved to have been formed but a few hundred feet from this surface. Instead of roots of veins, as in the Pacific and Appalachian belts, the prophylitic veins represent the uppermost part of the area of deposition along the fissure. While some of these veins yield steady and reliable products, many of them burst out in sudden blazes of glory like new stars only to be equally suddenly extinguished.

This belt of prophylitic veins is most extensively developed in Mexico. The central plateau contains the great silver veins of this class, which always contain a small amount of gold, and from which the greater part of Mexico's gold output has been derived.

Entering the United States, the prophylitic veins are found in Arizona and New Mexico.

The prophylitic veins of Arizona continue northward into Nevada and California. San Bernardino county in California contains silver deposits in rhyolite, and probably also tertiary gold veins. Veins of similar kind continue along the eastern foot of the Sierra Nevada as far north as Alpine county, and become more productive in Mono county; the mines at Bodie in andesite produced in nine years $12,000,000 gold, besides much silver.

No veins of this class are thus far known from British Columbia or the Northwest Territory, but on the Alaskan southern coast we meet sporadic cases again.

Returning again to Arizona, we trace its prophylitic vein northward into Nevada, and here we find this class abundantly represented. The Comstock vein, Tuscarora, Eureka, Tonapah, the De Lamar veins, all are known or believed to be of prophylitic character, and with the exception of the latter occur in volcanic rocks. The Comstock easily leads, with an estimated production of over $140,000,000 in gold, and the other districts have contributed heavily to the total output, although all contain much silver in their ores. The production of Nevada has fluctuated greatly, and after long declines is again increasing.

A line of prophylitic veins continues northward from Nevada into Idaho. In the southern part of that state they are represented by the Owyhee gold and silver mines, which, since their discovery, have yielded $12,000,000 in gold, and farther north by the bonanzas of Rocky Bar, Atlanta and Custer.

In Utah veins of this class occur, for instance, in the Horn silver mine and at Tintic, but these deposits carry very little gold.

Returning now to New Mexico, the prophylitic veins continue from that territory up into Colorado, and here reach a development not known elsewhere except in Mexico. The total output of Colorado is upward of $230,000,000, and but little of it has resulted from placer mining. In 1900 the output was $28,000,000. Excepting the Leadville deposits, the principal gold-producing districts of Tertiary age. Oldest among them as to discovery are the veins of Gilpin, Boulder and Clear Creek. These districts have been remarkably steady producers since 1859, and contribute annually about $3,000,000. They promise to continue in the same way for a long time. The next region is the San Juan district in southwestern Colorado, where strong quartz veins cut heavy andesitic

flows. The yield has increased greatly since 1890, and in 1900 reached $4,000,000. It promises well for the future, and some of the mines, like the Camp Bird, have proved veritable bonanzas. The output will probably continue to increase for some years.

Finally there is the great Cripple Creek district, which since 1892 has yielded $77,300,000, and during 1899, $18,000,000. The network of veins occur in andesite, phonolite and underlying granite, and have thus far chiefly carried telluride ores. A most important question, and one not easy to answer, is what may be expected of this district in the future. While recognizing the difficulty, it would perhaps seem admissible to express a belief that the highest mark has nearly been reached.

Roughly calculated, about $337,000,000 has been contributed by the prophylitic veins to the total gold output of the United States, to which should probably be added $200,000,000 from Mexico. For 1900 we may estimate $35,000,000 as the output of these veins in the United States, and perhaps $7,000,000 in Mexico.

Summing up the data obtained, we should estimate as follows:

	Total.	1900.
Pre-Cambrian	$144,000,000	$4,000,000
Cretaceous (Pacific)	1,400,000,000	50,000,000
Cretaceous (Central)	310,000,000	18,000,000
Tertiary, prophylitic	537,000,000	18,000,000
Total	$2,391,000,000	$116,000,000

The output of the pre-Cambrian veins will probably continue steady for many years. Owing to gradual exhaustion of northern placers (if no new important finds are made), the output from the Pacific cretaceous belt will probably decrease. California may be expected to hold her own for many years, and increase is probable in Idaho and Oregon. The central cretaceous veins may be expected to hold their own except if for some reason the copper and silver industries should decline.

Most difficult to calculate are the probabilities of the tertiary prophylitic belts. While the violent fluctuations in the cretaceous Pacific belt are due to placer discoveries, those in the prophylitic belt are caused by discoveries of vein bonanzas, and these cannot be foreseen. Another Cripple Creek may well be discovered. The New Tonopah camp of Nevada belongs to this class, and may be expected to swell the product of Nevada for 1901. Much is expected of Mexico's future gold product, and the rapid increase bids fair to continue for the next few years. Regarding the output from prophylitic veins in the United States, a decrease is probable if no new discoveries are made.

REPORT ON U. S. IRRIGATION INVESTIGATIONS FOR 1900.

The irrigation investigations conducted for a few years past by the U. S. Department of Agriculture, with Mr. Elwood Mead, M. Am. Soc. C. E., as expert in charge, are growing in value each year. Although a large part of the work relates to the cultural, administrative and legal phases of the subject, there is being made available a considerable amount of information of direct engineering interest, as is partly indicated by the following information, taken from the report of the work for the year 1900.

Reports from stations (comparatively few in number) located in ten States and Territories show an average rainfall during the irrigation period of 0.44 ft. in 1899, and 0.45 ft. in 1900, and an average depth of water applied to crops of 4.35 and 4.13 ft., respectively.

Measurements of losses by seepage and evaporation from 14 canals located in Arizona, Utah, Wyoming and Montana showed average rates per mile of from 0.29% from Canal No. 2, Wheatland, Wyo., in August, 1900, to 6.60% from the Logan, Hyde Park & Wheatland Canal (Utah) in 1900. The mean for the 14 canals was 2.47%. The figures given are percentages of total volume carried, from which it would follow, if the losses remained uniform, that in a distance of 40 miles practically all the water would be lost, "leaving none to be distributed through surface laterals." This, Mr. Mead states, "does not often occur in practice." The high figures are largely due to Utah canals in bad condition.

As to the feasibility of pumping water for irrigation, investigations in Arizona indicate

that on lands yielding large returns pumping to supply the deficiencies of the natural flow of streams is not only practicable, but highly profitable where the lift does not exceed 60 ft.

With wood at $4 per cord, and with an application of 4 ft. of water, in depth, the cost of raising water 50 ft. was about $10 per acre. On Cache Creek, in California, water has been raised 10 to 35 ft. for $5.25 per acre. On Fresno Slough, California, "several electrical pumping plants have been installed at a cost of $8,000 each, which have irrigated land at an expense for operation of from 25 to 35 cts. per acre."

The volume of silt carried by streams is being investigated for the department by Prof. J. C. Nagle, of the Agricultural College of Texas. Mr. Mead gives a brief summary of Professor Nagle's report in this volume, from which the following table, with the omission of two estimates, is taken:

Average Percentage of Silt to Total Volume of Flow in Certain Streams.

Stream.	Date of samples.	Avg amt. silt carried. Total	Less 25% for shrinkage.*
Brazos River, Tex.	May, '99—Nov., '00	1.09	0.81
Rio Grande, Tex.	June and July, 1900	0.34	0.25
Pecos River, N. Mex.	July, 1900	0.43	0.33
Pecos River, N. Mex.	July to Dec., 1899	0.15	0.12
Laramie River, Wyo.	May to Oct., 1899	0.013	0.01
Salt River, Ariz.	May to July, 1899	0.18	0.14
Wichita River, Tex.	May, '99—Sept., '00	1.34	1.00

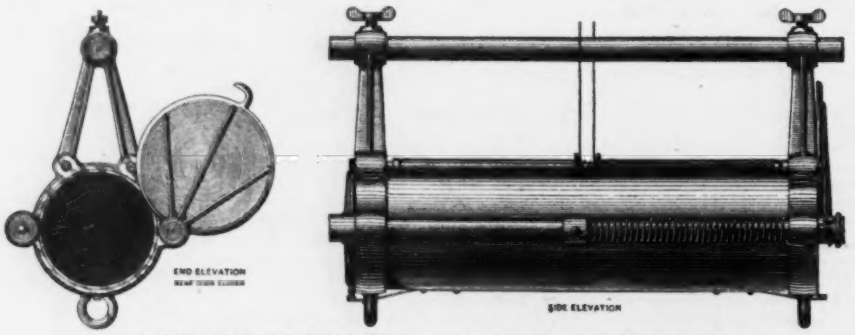
*Based on measurements of sediment in samples left standing for one year.

The foregoing statements were taken from Mr. Mead's brief introduction to the reports from the various observers. Mr. C. T. Johnston, Assistant in Irrigation Investigations, also presents editorial summaries of the several reports, together with some orignal matter. Among other statements about water registers, for ditch heights, he records the fact that these useful devices are becoming cheaper and that a greatly increased use of them is desirable.*

A water-register testing station has been established by the Department at the city water-works pumping station, Cheyenne, Wyo. It consists of a tank, "with automatic water connections, which cause continuous fluctuations in the height of the water surface." The tank is large enough to test three or four registers at once. On account of the changes in design, it is considered necessary to test each new part of water registers. The tests show whether a pen or pencil may best be used, and, if a pen, the proper ink and paper; also whether the sharpening and adjustment of the pen are needed. By these and other means the condition of the apparatus is carefully determined and defects made good before it is sent into the field.

There has also been established at Cheyenne a rating station for current meters of the electric type. This station, also, is in connection with the city water-works, being located at and on a reservoir. All current meters are rated here [illegible] being sent out for field work, and also on [illegible] turn to the station.

*For an illustrated description of several registers, and instructions for installing weirs, measuring flumes and registers, see article by Mr. Johnston in Engineering News, Aug. 29, 1901.



WATER SAMPLE TRAP FOR USE IN SILT INVESTIGATIONS.

Another interesting feature of Mr. John[illegible] section of this report is a descriptoin of a [illegible] sample trap for silt investigations, which we print as follows:

It consists primarily of a brass cylinder 1 ft. [illegible] 3 ins. in diameter. At each end is a door which [illegible] on a horizontal shaft. This axle runs the length [illegible] cylinder, and the rapidity with which the door [illegible] regulated by a stiff steel spring which is coiled around [illegible] axle and fastened to the same by a sleeve furnished [illegible] set screw. Near the top of the cylinder are two [illegible] rods which are also furnished with springs, whose [illegible] tion is to move the ends of the rods beyond the pla[illegible] which the doors slide when they revolve. As soon [illegible] doors are open, therefore, these rods hold them in th[illegible] sition until they are withdrawn. This result is a[illegible] plished by pulling two cords which are fastened [illegible] rods. The trap is also furnished with a vane which [illegible] the cylinder parallel with the current. To use the t[illegible] is suspended in the water at the desired depth, and [illegible] all is ready the doors are simultaneously closed by [illegible] device just described.

In silt measurements it is necessary that enough sam[illegible] be collected to enable a mean value to be determined. [illegible] first is therefore generally taken from the top and [illegible] work continued until the bottom is reached. As soon as the samples are taken, each is emptied into a jar of [illegible] kind and shipped to the station, where the analysis is made. The analysis not only determines the percentage of solid matter held in suspension, but also shows the nature and weight of each ingredient.

NOTES ON THE HISTORY OF TURBINE DEVELOPMENT IN AMERICA.

By A. C. Rice,* M. Am. Soc. M. E.

Perhaps no other machine of equal importance in the engineering and manufacturing world has received as little mention as the standard turbine water wheels which are every day driving the busy machinery of hundreds of woolen, cotton, flouring, pulp and paper mills, and manufactories of every variety of industry along the swift streams from the Atlantic seaboard to the Pacific coast.

It is interesting to note that probably the first water wheel to be used in manufacturing in New England or the New World was that built by Joseph Jenks, master mechanic of the Saugus Iron Works, of Lynn, Mass., for the works of that company on the Saugus River near Lynn. A patent was granted him by the General Court of Massachusetts in 1646 for a water "engine." In 1900 it is conservatively estimated there were fully 75,000 water wheels in operation throughout the country.

Until nearly 1850, the old-fashioned overshot or breast wheels held undisputed sway. In the early '30's, when the great cotton mills of Lowell were built, breast wheels of large dimensions were constructed to furnish the requisite power. Those in the mills of the Merrimac Manufacturing Co. were 30 ft. in diameter, with buckets 12 ft. long, all built of wood.

These breast wheels marked a high stage of development in that class of wheels, giving good power and efficiency, and until 1844 were considered the most perfect wheel that could be built, as there existed much prejudice against the crude reaction wheels that were being tried in some of the smaller mills.

Some French turbines were imported about this time, and though their construction was poor and efficiency low, yet they won favor because of their cheapness, small space occupied, less trouble from back water and ice in winter, and their increased speed. These advantages were only too apparent to mill owners, who had more water than money in those days.

Mr. Uriah A. Boyden, then of Boston, Mass., was the first American to design a turbine which was destined to displace the breast wheel and become the forerunner of a very important industry in America. In 1844 Mr. Boyden installed in the cotton mills of the Appleton Co., of Lowell, his first turbine, rated at 75 HP. This wheel in its essential parts was similar to the Fourneyron turbine, an outward discharge wheel, which was developed in France some 10 years previously. Mr. Boyden's wheel was carefully tested by a Prony dynamometer and yielded an efficiency of 78%, which was a very surprising result to mill owners, as the breast wheels were only giving from 60% to 75% efficiency.

In 1846 Mr. Boyden again designed three simi-

*Consulting Hydraulic and Mechanical Engineer; State Mutual Building, Worcester, Mass.

ir turbines of 190 HP. each for the same com- any. His terms with the company were that he hould receive the patent rights and $1,200 for his ervices if the wheels gave 78% efficiency, and 100 for every 1% in excess. Accordingly, the heels were tested by the late James B. Francis, e engineer for the Proprietors of the Locks and anals on the Merrimac River at Lowell. Mr. rancis claimed an improvement in calculating ests and by using the Prony dynamometer he und the wheels to yield 88% useful effect. So Mr. Boyden received $5,200, which was paid by he company without complaint.

In 1849 Mr. Boyden sold his improvements on is turbine to the manufacturing companies of owell, and it fell to Mr. Francis, as their en- ineer, to design and erect wheels for the mills. His first designs were for four turbines, two for he Suffolk and two for the Tremont Mills. These urbines were built at the Lowell Machine Shop nd completed in January, 1851. In testing one of the Tremont wheels, Mr. Francis made some very elaborate experiments which have been most invaluable to hydraulic engineers. The best show- ing made by his turbine was 79% efficiency, with a speed of 62% of that due the head and at part gate the efficiency dropped rapidly.

After the success of these turbines, numerous inventors set to work, and as a result some new types were brought out. First, there was the in- ward or center vent wheel, the design of J. B. Francis, and then the downward discharge or axial flow turbine of the Jonval type.

In 1859-60 the city of Philadelphia tested several small wheels for different builders, the most not- able of which was the test of the Jonval turbine built by J. E. Stevenson, of Paterson, N. J. This wheel gave an efficiency of 90.77%, but it was generally thought that the method of testing em- ployed was defective, and the tests had little in- fluence.

The first real rival that the Boyden wheel en- countered was the design of A. M. Swain, of North Chelmsford, Mass. The new features of this wheel were its many buckets, small openings, an inward flow with bucket curved down to give a freer dis- charge, its small size and cheapness, as compared with the large and expensive Boydens. An early test of a 21-in. Swain wheel gave 80% efficiency under a head of 17.91 ft., the wheel developing 25.55 HP. and making 281 revolutions per minute.

About the same time James Leffel, of New Haven, Conn., came out with a wheel of still dif- ferent type. As the best wheels previous to this time had been either outward, inward or down- ward discharge, when on a vertical shaft, as all turbine wheels were at that time, Mr. Leffel con- ceived the idea of improving and uniting two of the best forms into one wheel. After long and tedious experimenting and with various modifica- tions he produced a wheel which was a combina- tion of an inward discharge and a downward discharge runner, there being two distinct sets of buckets, yet both receiving their water from the same guide openings. The water acts singly and only once upon each set, instead of running the same water through each set of buckets, placed one above another, as many builders at that time were doing. An early test of this wheel 30½ ins. diameter gave 74% efficiency under a head of 15.40 ft., with 31.82 HP. and 175 revolu- tions. The gate work was very different than that used on the Boyden and Swain wheels, which had cylinder gates. It consisted of a series of pivoted plates, which were opened and closed to regulate the water supply, at the same time acting as guides.

In the early '70's the Risdon and American tur- bines took their place alongside of the other wheels. The Risdon was the design of T. H. Ris- don, of Mount Holly, N. J. The wheel runner is of the inward and downward discharge type, and all cast in one piece. The cylinder gate had a wide flange on its lower edge to help guide the water without producing eddies, as the sharp plain edge of the cylinder gate would do. The first test by James Emerson of one of these wheels 43 ins. diameter gave an efficiency of 86.3% under a head of 18.25 ft., 52 HP., 163.5 revolutions.

After making some improvements Mr. Risdon had another 43-in. wheel tested on April 28, 1874, which gave as high as 91.32% efficiency under 17.91 ft. head, 82 HP., 131 revolutions. A 25-in. wheel, tested July 21, 1874, gave 86% under 18.61 ft. head, 25 HP., 256 revolutions per minute. A 54-in. wheel tested in 1876, gave 81.77% under 8.66 ft. head, 50 HP., 78.5 revolutions.

It was very evident from these tests made by Mr. James Emerson, who invented the dynamom- eter brake, now used to test turbines in the flume of the Holyoke Water Power Co., at Holyoke, Mass., that it was the best wheel built at that time.

In the Western States, where water power was abundant, there sprung up in the early days many devices to utilize this power, as transportation was costly and slow from points in the East for such heavy wares as water wheels. Of the many crude wheels put on the market but few survived and chief among these was the American wheel. This wheel runner did not differ much in principle from the Swain wheel, it being an upper and lower ring with the buckets in between, but cast all in one piece, while in the Boyden and Swain the buckets were separate and either fastened or cast into the rims of the wheel. The gate work was similar to the Leffel, except that the guides were formed by two plates, one fixed and the other movable, and pivoted near the inside diameter of the guide case. To control the wheel these mov- able plates were operated by rods connected to a circular plate on the dome. The plate had a strong arm and segment gear thereon with a pinion on the gate shaft. When the circular plate was rotated the gate plates moved with it, thus changing the size of openings without altering very perceptibly the direction or velocity of the water entering the wheel.

A test of a 48-in. American wheel on June 11, 1873, gave 83.14% efficiency under 18.10 ft. head, 99.86 HP. and 108 revolutions. The test of an- other 48-in. wheel on Jan. 29, 1874, gave 75.98% efficiency under 17.65 ft. head, 86.24 HP., 108 rev- olutions.

Another western wheel was the "Eclipse," man- ufactured by the Stilwell & Bierce Manufacturing Co., of Dayton, O. The runner of this wheel was similar to the "American," except that it had a double set of buckets. It had the two outside rings to hold the buckets, with a ring in between to form a partition between the upper and lower set of buckets, which alternated with each other. This wheel was fitted with an internal register gate. An early test of a 30-in. "Eclipse" gave 76.28% efficiency under 18.79 ft. head, 33.85 HP., 185 revolutions.

In 1876 McCormick & Brown, of Brookfield, Pa., sent four 24-in. turbines to the Holyoke testing flume to be tested. Up to that time all that was expected from a 24-in. wheel was from 15 to 25 HP., but these turbines developed 70 HP., with an efficiency so remarkable that the first wheel was taken from the flume, examined, reset and tested again and again. Experts and several builders of acknowledged ability were called in to assist in making the test, so that no chance of questioning its accuracy should remain. The results were: At whole gate, 18.04 ft. head, 206 revolutions, 70.52 HP., 83.86% efficiency. At part gate, 18.23 ft. head, 214 revolutions, 64 HP., 89.22% efficiency.

As high useful effect at whole gate had been ob- tained by several builders, but at part gate no such averages at all stages of opening had been attained as the "Hercules" gave at these tests. Its power in proportion to its diameter was so very far ahead of anything ever before produced that it might be said to be a new departure in turbine design. The runner had an inward and downward discharge bucket, which had three projections near the intake to help guide the water at part gate. The number of guides and buckets was reduced and the size of the openings largely increased, as compared to previous de- signs. This fact enabled it to discharge more water, and thus gave it more power for the same diameter, besides letting floating obstructions in the water pass through without clogging it up. Wheels of the older styles, like the Boyden and Swain, often became stalled or damaged by sticks and leaves, and even eels sometimes choked up their narrow passages.

The Holyoke Machine Co., of Holyoke, Mass., an old and reliable firm, which was building the Boy- den and Risdon wheels, was quick to realize the possibilities of the Hercules, and lost no time in securing the patents and services of its inventor, Mr. John B. McCormick, to develop the other seventeen sizes. When Mr. McCormick came to the company he had no drawings or method of procedure, and the "cut and try" process was the system followed. To Mr. Stephen Holman, Treas- urer of the Holyoke Machine Co., is due great credit for his liberality of expenditure in the effort to perfect the Hercules turbine.

But the Holyoke Machine Co. was not alone in its efforts to have the best wheel on the market. Other builders began to revise their patterns, and, as a result, in 1879 several sent their wheels to the Holyoke testing flume for a competitive test. The following are some of the tests made at that time by Mr. Emerson, aided by Samuel Webber, C. E.

On Sept. 5, 1879, a 35-in. "Victor" turbine sent by the Stilwell-Bierce Manufacturing Co., of Dayton, O., gave 82.89% efficiency, under 17.18 ft. head, 134 HP., 147.5 revolutions. This wheel was an improvement on their former "Eclipse," and somewhat similar to the Hercules in having large openings, very long buckets shaped with easy curves, giving an inward, downward and out- ward discharge, its inside register gate working easily. The buckets were cast separately, and after being polished were cast into the rim and hub.

A 15-in. wheel when tested and found to give more power and efficiency than the Hercules was named "Victor." This 15-in. wheel was tested by Emerson, March, 26, 1878, and gave 91.39% effi- ciency, under 18 ft. head, 30.12 HP., 355 revolu- tions. It was then taken out, altered and reset, and tested some weeks later, giving 91.41% effi- ciency, under 17.94 ft. head, 30.40 HP., 352 revolu- tions. These results were so remarkable that this wheel was placarded and consigned to the store- house, where it can be found to-day.

On Oct. 14, 1879, a 48-in. "New American" from Stout, Mills & Temple, of Dayton, Ohio, was teste l and gave at whole gate 77.83% efficiency, under 16.32 ft. head, 135 HP., 108 revolutions; at part gate, 80.15% efficiency, under 16.90 ft. head, 115 HP., 117 revolutions. This wheel was a great improvement over their old "American" wheel. It had about the same gate arrangement, but better shaped buckets with increased discharge. Its high part gate results were its peculiarities, giving its highest efficiency when discharging about three-quarters maximum water. This fact was taken advantage of where the working load is variable, with the lighter load predominating.

On Jan. 3, 1880, another 48-in. "New American" was tested, and gave at whole gate 77.23% effi- ciency, under head of 13.21 ft., 112.95 HP., 105 revolutions; at part gate, 81.26% efficiency, under head of 13.22 ft., 102 HP., 112 revolutions. The capacity of this wheel was double that of the old 48-in. American tested June 7, 1873, which gave 75.55% under 11.87 ft. head, 48 HP., 87 revolu- tions. The discharge of this wheel was 2.857 cu. ft., against 5,862 cu. ft. for the former.

The test of a 33-in. Hercules on Nov. 4, 1879, gave 80% under 17.07 ft. head, 122 HP., 155 revo- lutions.

During the eleven years the writer was with the Holyoke Machine Co., from 1874 to 1885, he had every opportunity as foreman of their pattern shop, millwright work, and as engineer and super- intendent, to study the construction and tests of different wheels, and designed and equipped many water-power plants. Among them was a design embodying a horizontal wheel, or turbine on a horizontal shaft; but as horizontal wheels were an innovation, the chief engineer of the company did not approve of them. The writer resigned his position in 1885 to accept that of chief engineer and superintendent of the Stilwell & Bierce Manu- facturing Co., of Dayton, Ohio, where he at once took up the designing of both horizontal and ver- tical wheels. A pair of horizontal wheels 30 ins. diameter were built in 1886 by this company, using the same runners on horizontal shaft. This case was probably the first instance where two turbine runners, one right and the other left hand, were put on the same horizontal shaft inside the same flume.

The following table is the record of sales of the Stilwell & Bierce Manufacturing Co. for 12 years, and shows the complete reversal in the use of the vertical and horizontal wheels.

Year.	Wheels: Vertical No.	Vertical HP.	Horizontal No.	Horizontal HP.	Total HP.
1886.....	137	12,592	1	120	12,712
1887.....	163	16,079	18	2,261	18,340
1888.....	136	17,331	50	5,144	22,475
1889.....	144	21,434	29	3,073	24,507
1890.....	129	17,827	98	7,965	25,792
1891.....	84	10,430	72	9,576	20,006
1892.....	81	8,229	151	29,451	37,784
1893.....	43	4,645	113	22,078	26,723
1894.....	46	4,409	66	18,865	23,274
1895.....	34	3,511	127	25,188	28,699
1896.....	104	23,291	209	43,936	67,227
1897.....	32	3,250	105	27,010	30,260
Total.....	1,153	143,028	1,139	194,717	337,745

As the development of electrical apparatus was calling for the greatest speed and power that could be obtained from a single wheel under conditions where a standard turbine could be used, a new design of the Victor was made in 1890, which increased its capacity about 20%. The draft tube was lengthened to permit the bridge tree and step being placed lower so as to give freer discharge from the buckets. Also, the cylinder gate was substituted for the register gate. In 1894 the buckets were re-designed to give a larger discharge, and the increase in power was about 10%, so that then the Victor stood above all others in point of speed and power.

However, by this time all wheel builders were striving to meet competition, by reducing the cost of their wheels, yet keeping them up to a high average of power and efficiency, so that the cost of the turbines per horse power was less than one-fourth the old time Boyden wheel equipment.

In 1898, after the writer resigned his position with the Stilwell-Bierce & Smith-Vaile Co., to devote his attention to special engineering work, he began the design of a turbine to improve upon the Victor, which was already doing such excellent work. In 1900 was completed a full set of drawings for sixteen different sizes, both of the details of the buckets and the wheel sections.

These designs were sold to Stilwell-Bierce & Smith-Vaile Co. under guarantee to give 10% more power than the Victor and a minimum efficiency of 80% at full gate, with the understanding that they might select any size and have it tested at the Holyoke testing flume. Accordingly a 27-in. wheel was selected, built and tested, giving 6⅝% more power and 1.47% better efficiency than the agreement specified.

To show the increased speed and power of this design over previous wheels of various designs, including the first Hercules that gave such wonderful results in 1876, the accompanying table is given. As the head under which these wheels were tested varied, the results are computed for 20-ft. head and best results for full gate to make the comparison clear to the reader.

Wheels.	Tested by.	Date.	Head.	Revs.	HP.	Efficiency %.
24" Hercules	Emerson	March, '76.	20'	210	82.32	83.86
25" Victor..	Emerson	July 25, '77	20'	209	66.16	75.33
24" Hercules	Holyoke	July 16, '81	20'	218	79.25	80.0
24" Rice....	Water	Jan. 24, '01	20'	240	124.52	82.84
12" Victor..	Power	Jan. 29, '01	20'	531	30.95	84.14
27" Victor..	Co.....	Nov. 9, '00.	20'	231	155.77	81.47

As a further comparison, the tabled properties of some of the most prominent wheels of to-day are given in their catalogues:

Wheels.	Diameter.	Head.	Revolutions.	HP.	Water, cu.ft.	Efficiency.
Hercules .....30 ins.		20 ft.	174	119.59	3,900	80%
Samson .....30 "		20 "	242	162.00	5,312	80%
McCormick ..30 "		20 "	186	142.70	4,721	80%
Victor .....30 "		20 "	210	165.35	5,471	80%
Rice's Victor..30 "		20 "	222	183.72	6,079	80%

Modern engineering, especially in the driving of electric generators and other rapid-running machinery, imposes new and very difficult conditions upon the designers and builders of water wheels. In the case of the electric generators, for example, these require a large power and high speed. In view of these requirements a direct connection to the turbine shaft is preferred, wherever it is possible to have it, because such direct connection avoids all possible loss of power through transmission appliances. These conditions frequently necessitate the grouping of several turbine wheels in order to form a unit of power suited for the purpose in hand.

To operate the gates of these wheels and have them all work in unison, a mechanism was patented by the writer in 1899 consisting of two pairs of rods extending through the flume head and connecting to the gates. One pair connected to the gates of the right-hand wheels, while the other pair connected to the gates of the left-hand wheels. On the ends of the rods outside of the flume head were racks, operated by pinions on the governor shaft and so arranged that when the pinion turned in one direction it would draw one pair of rods out and push the other pair in, thus operating the gates simultaneously, no matter how many there were. Heretofore for actuating the speed-gates of turbine wheels use had been made of racks and pinions situated on the inside of the water-wheel casing. These gears thus placed out of sight were in a place difficult of access, and, furthermore, were subject to very rapid wear because of the constant working in water which contains more or less grit. But by the arrangement of the gate-operating mechanism described above, all the working parts are placed on the outside, where it is not only accessible, but in plain view of the operator, and the working parts, instead of grinding in water, can be operated in a bath of oil.

Another important feature of a modern water-wheel equipment is the momentum wheel, especially for loads that vary suddenly, as in electrical street-car work, electrical power distribution, etc. This is built usually of steel plates riveted together to form the rim, with two or three plates forming the web, and bolted to a heavy cast-iron hub. More recent ones are built with heavy steel-forged tires. Such wheels often weigh many thousand pounds and run with a peripheral speed of from 5,000 to 9,000 ft. per minute.

So with the modern water-wheel equipment, consisting of well-designed horizontal wheels, steel penstock, flume and draft tube, with generator direct-connected and momentum wheel on the same shaft, the whole apparatus may be set upon the tiled floor of a neatly arranged power house. As you turn to look out of the window, you can scarcely hear the fast revolving machinery, so noiselessly does it run, and one can but marvel at the change from the slowly revolving breast wheel of fifty years ago.

A TROLLEY-CAR STREET SPRINKLER WITH SPRAY REINFORCED BY COMPRESSED AIR.

The evolution of the trolley street sprinkler is interesting. In our issue of May 30, 1901, we described a curb-to-curb sprinkler, made by the American Car Sprinkler Co., of Springfield, Mass., which had been in use in Springfield since 1895, and which was then (1901) in use in eight other places. The chief feature of that sprinkler was a long, perforated arm, which, to avoid street traffic, was attached to one side of the car only, thus necessitating two trips to cover the street. Ordinary tank pressure was employed, from a 2,000-gallon tank.

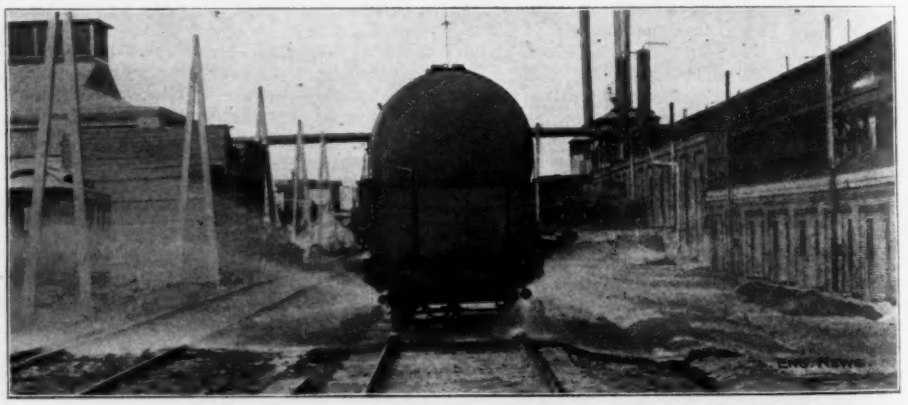
Later in the same year (Nov. 14, 1901) we described what we then said seemed "to be a decided further step in advance," which was the application of pressure to the spray, by means of pumps mounted in the car and driven by separate motors. This sprinkler had a head about midway and just beneath the body of each side of the car, thus not interfering with traffic, and another sprinkler for the right of way and to flush the rails. It was made by the Studebaker Bros. Manufacturing Co., South Bend, Ind., and after being tested in that city one had been sent, late in 1901, for use at Colorado Springs, Colo. The capacity of the tank was not stated. The tanks in each of the types of sprinklers already described were mounted in cars resembling ordinary passenger or baggage cars.

The accompanying illustration shows the latest development in trolley street sprinklers which has come to our attention, namely, the use of compressed air to control the spray. Two of these cars have recently been put in use by the Pittsburg Railways Co., of Pittsburg, Pa. The sprinkler, according to a statement by the manufacturers, the J. G. Brill Co., of Philadelphia, was invented by Mr. Jas. Rawle, Treasurer of the company named. It will be seen that the steel tank is mounted on the car without housing. A standard tank is 6½ ft. in diameter, and holds 2,500 gallons.

The air compressor is carried on the car, at the side of the tank, and is driven from the car axle by means of a sprocket chain. A clutch and lever enables the motorman to start or stop the compressor at will. The compressor is designed to give a large volume of air at low pressure, the latter being controlled by a valve set for any desired pressure between 2 and 20 lbs. When the pressure for which the valve is set is about to be exceeded the air is blown off automatically. The water may be delivered so as to cover any desired distance on one or both sides the track. With 15 lbs. pressure, the manufacturers state, water can be evenly distributed to a distance of 30 to 35 ft.

Besides separate sprinkler pipes for washing the rails, there are four sprinkler heads, one at each corner of the car. The tank is provided with a sight gage, and can be filled from the bottom through a check valve.

For the information regarding the compressed air sprinkler we are indebted to the Brill Co., and to Mr. H. P. Clarke, Superintendent of the Mechanical Department of the Pittsburg Railways Co.



TROLLEY STREET SPRINKLER WITH SPRAY CONTROLLED BY COMPRESSED AIR.

ANNUAL CONVENTION OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

The twenty-first annual convention of this association was held at Boston, Sept. 10 to 12. The members and guests in attendance numbered about 300, and the convention was considered to be one of the best ever held. There were three sessions for general business and the presentation of papers on Wednesday, and again on Thursday, with no side shows to detract from the success of the meetings.

Friday was devoted to a trip over the various portions of the Metropolitan Water-Works now under construction, including the large masonry dam at Clinton, various sections of the Weston Aqueduct, the Weston regulating reservoir, and the pipe lines which form a continuation of the aqueduct. Further mention of these works will be found below.

The opening business was brief, but was made notable by the election of the first honorary member under the new constitution. This double honor was very fittingly bestowed upon Mr. Alphonse Fteley, Past-Pres. Am. Soc. C. E.

DUTIES OF MUNICIPALITIES REGARDING WATER SUPPLY.

Mr. J. O. Hall, of Quincy, Mass., spoke on this subject from the view-point of a mayor who has taken unusual interest in water supply matters. He believed water-works is one of the few

public utilities which should be under municipal ownership. He did not favor restricting the use of water, except that he would discourage its use for driving water motors. Manufacturing services should be metered and fire hydrants should be under the charge of the fire departments. Uniformity of accounts among different cities, he thought, is well-nigh impossible. He did not favor putting all the cost of the public service on the various municipal departments, and he did favor making the charge for domestic service light.

Several members discussed this paper and called attention to the frequent confusion of use and waste of water; the desirability of separating the cost of public and private service and putting the burden of each on the respective parties benefited; and the possibility of accomplishing something worth while in the way of uniform statistics. Mr. Freeman C. Coffin, M. Am. Soc. C. E., suggested as a fair rough-and-ready method of apportioning the cost of fire service that it be made one-half the total cost of maintenance. He thought the tendency to charge merely nominal rates for water used to drive motors is wrong.

STANDARD SPECIFICATIONS FOR CAST-IRON PIPE.

The report of the committee on this subject was accepted and adopted, including the specifications printed in our issue of Sept. 11. Mr. Dexter Brackett, M. Am. Soc. C. E., a member of the committee, stated that conferences had been held with foundrymen representing the owners of some twenty different foundries, including the U. S. Cast Iron Pipe & Foundry Co., R. D. Wood & Co., Warren Foundry & Machine Co., Donaldson Iron Co., and foundries at Radford and Lynchberg, Va. There was some discussion about the number of classes of pipe given in the specification, but the concensus of opinion seemed to be that these were by no means too numerous for general specifications. Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., contrasted the small advances made in distribution systems, which systems form so large a percentage of the cost of water-works, with the marked improvement in pumping machinery. He thought that engineers ought to insist on much better pipe than is now made, and favored the sand blast method of cleaning before coating, and a higher grade of coating. It is possible that porcelain enamel coating may yet be used. It would add 15 to 20% to the cost of the pipe, but would ensure the full carrying capacity of the pipe during its life, besides being proof against electrolysis. One or two members approved Mr. Benzenberg's suggestions for more rigid specifications, and several called attention to the laxity so often shown in enforcing existing specifications. Both Mr. Brackett and Mr. Coffin again urged that the specifications were for general use, and that as time went on their requirements might easily be raised to a higher standard. The specifications were finally adopted, with the understanding that the committee would complete tables showing the details of special castings.

RECENT CONSTRUCTION ON THE METROPOLITAN WATER-WORKS.

A talk on this subject, illustrated by lantern slides, was given on Wednesday evening by Mr. F. P. Stearns, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Water and Sewerage Board. Some of the chief points of interest heard during the talk and seen on the subsequent excursion over the works, may be briefly reported as follows:

The Wachusett Dam. at Clinton, is now well "out of the hole;" that is, the portion below the bed of the stream has been more than completed. The present height of the masonry above the rock foundation is about 85 ft., out of a final height of about 205 ft. The contract date for completing the dam is Nov. 15, 1904. The contractors are McArthur Bros. Co., of Chicago, with Winston Bros. & Locher in charge for the contractors. The contract price for the masonry dam, alone, is $1,604,000. The main part of the contractors' plant includes two 500-HP. compound condensing Corliss engines, driving two double Rand compressors; also two Lidgerwood cable railways with a span of 1,150 ft., and a capacity of eight tons each. The cableways are mounted on movable towers, 60 ft. high at one end and 90 ft. high at the other end of the dam. Heavy bull wheel derricks are used for placing the big blocks of masonry composing the dam. Mr. Stearns said, in his address, that when the work was started each stone was bedded in mortar, lifted, and then rebedded. After some experience the inspectors became able to tell, without lifting every block, whether rebedding was necessary. He thought that good bedding was secured, notwithstanding the claims that such is impossible, recently made during the discussion of Southern dams. The big flume, used for a number of years to convey the freshet flow of the river, has been cut away to make room for the dam. In heavy floods the water will flow over a gap in the dam.

A unique contractors' plant, that is for aqueduct work, is being used on the construction of the Weston Aqueduct. The general, if not the universal, practice heretofore, Mr. Stearns said, has been to mix the concrete for aqueduct work by hand. Mr. Locher, of the contractors for portions of the aqueduct, has provided stone crushing and concrete mixing plants for each 4,000 ft. of aqueduct. At the plant seen on the trip the gravel pit and concrete plant are close by the aqueduct line. Big boulders from the pit and large stones from the gravel screens are sent to the crusher. A revolving concrete mixer is employed. The larger stone are lifted in skips, and the gravel and sand by bucket elevators. The embankment is built to the level of the springing line of the arch, and at this level tracks and dump cars are used to convey material.

Two 7½-ft. riveted steel pipe lines are used to cross beneath the Sudbury River, and to save a high embankment across Happy Hollow valley. Pneumatic riveters are employed. The pipe is coated with Assyrian asphalt. Edward Kendall, of Cambridgeport, is contractor for these pipe lines.

THE WATER SUPPLY OF NASHUA, N. H.

Mr. H. G. Holden, Superintendent of the Nashua works, described the evolution of a water supply through a long period of years. Surface water was used until recently, when a fine supply of spring or artesian water very near the surface was developed in a location from which it flows by gravity to the pumping station. Water power was used for pumping for many years, then water and steam power, and finally water power again, the latter under a head of 60 ft. (Eng. News, June 6, 1901.)

THE REMOVAL OF COLOR AND ODOR FROM WATER.

Mr. H. W. Clark, Chemist of the Massachusetts State Board of Health, reviewed some of the experiments along this line made at Lawrence and elsewhere. Two slow sand filters in use for a number of years at the Lawrence Experiment Station, operating at rates of 2,500,000 and 3,000,000 gallons, respectively, removed an average of about 33% of color. In general, less color was removed when the rainfall was highest, the percentage sometimes falling to 20, while in other years the amount removed was 50 and sometimes 60%. The foregoing experiments were made with water from the Merrimac River. Beginning with 1899, decaying vegetable matter was added to Merrimac water placed in a tank, and the decoction was applied to a number of slow sand filters. With filtration at rates of 2,000,000 to 5,000,000 gallons per acre per day from 60 to 80% of the color was removed. Old organic matter, giving rise to more bacterial action than less easily fermented material, showed a higher degree of color reduction. It was found that by using alum or ferric chloride practically all the color could be removed.

For some 13 months, ending with January, 1902, studies were made of the effect of single and double filtration on the frequently troublesome water from the Ludlow reservoir, Springfield, Mass. Single filtration at rates of 2,500,000 and 5,000,000 gallons, removed about 63% of color, and a second filtration of the same water, but at a rate of 10,000,000 gallons, brought the total removal up to 75%. These figures were for the "worst" five months, but earlier and later single filtration gave results ranging from 17 to 40%. At another place, sand filtration has removed nearly all the color.

Odors are easily removed from the Merrimac River with sand filters working at a high rate of speed. The Ludlow reservoir water was practically freed from odor by single filtration at rates of 2,500,000 and 5,000,000 gallons, until July, when anabena gave a decided odor to the effluent. Double filtration removed all the odor. There was no discussion on this paper.

THE PHYSICAL PROPERTIES OF WATER.

Mr. Allen Hazen, M. Am. Soc. C. E., described the new pocket apparatus for determining color and turbidity devised by Mr. Geo. C. Whipple, Assoc. M. Am. Soc. C. E., and himself, for the use of observers in behalf of the U. S. Geological Survey. Descriptions of the devices and their use may be secured by writing to Mr. F. H. Newell, M. Am. Soc. C. E., Chief Hydrographer, Washington, D. C. A brief description of the devices was given in our issue of May 15, 1902, but it may be added that the turbidity scale now used has been improved and gives a direct reading, on a percentage basis, instead of a reciprocal of the depth at which the platinum wire disappears. Mr. Hazen urged the importance of securing turbidity and color records throughout the country, and stated that the scales would soon be placed upon the market. Mr. Robt. S. Weston, Assoc. M. Am. Soc. C. E., stated that some comparative tests of a diaphonometer, platinum wire scale, and the silica standard for determining the turbidity of the Mississippi River water at New Orleans showed that the diaphonometer was more accurate than the wire, where the former could be used, but that the diaphonometer should not be employed for depths of more than 40 ins., and that rather than use it at depths of 1 in. or less the water should be diluted. The platinum wire scale is by all odds the most convenient one for field use. The diaphonometer has the advantage of being usable at night.

OTHER PAPERS AND BUSINESS.

The committee on "Uniform Statistics" made a report recommending the consolidation of the two financial schedules heretofore used in the standard form for water-works reports. It stated that water purification schedules had been started and requested permission to go on with them and give them a trial before formally reporting them for adoption. The recommendations, as well as a few minor changes in the schedule, were approved.

Dr. E. M. Hartwell, Secretary of the Boston Statistical Department, and Chairman of the National Committee on Uniform Municipal Accounts and Statistics, reviewed briefly several phases of the general subject, and emphasized the desirability of separating ordinary and extraordinary revenues and expenses, respectively, in all financial statements, thus making clear whether the funds expended are properly classed as income or as proceeds from bond issues, on the one hand; and, on the other, whether the expenses belong to maintenance or construction.

At the last session, on Thursday evening, there were two features of unusual interest. Mr. Desmond FitzGerald, M. Am. Soc. C. E., gave a talk, accompanied by lantern slides, on "What an Engineer Saw in Venice," dealing chiefly with the waterways and architecture of the city. Mr. R. C. P. Coggeshall, of New Bedford, Mass., one of the charter members of the association, presented a historical address, entitled "Twenty Years After—A Retrospect." Mr. Coggeshall reviewed in particular detail the early years of the association, showing how the subject of forming such an organization was canvassed before the American Water-Works Association was founded. His address was pervaded by that genial and friendly spirit upon which the success of the association has been so largely built. Its appearance in full in the "Journal" of the association will be welcomed by those who heard it, as well as by those who did not.

Abstracts of the paper on "A New Turbidimeter," by Chas. Anthony. Jr., C. E., of Glenview, Hereford, England, and of the report on "Apportionment of Charges for Private Fire Protection, and the Means of Controlling the Supply Thereto," are given elsewhere in this issue, as also a list of exhibitors at the convention.

The following committee was appointed to report nominations of officers to be elected at the annual meeting in January, 1902: Desmond FitzGerald, of Boston; F. H. Crandall, of Burlington, Vt.; Byron I. Cook, Woonsocket, R. I.; Joseph Beals, Middleboro, Mass.; V. C. Hastings, Concord, N. H.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
} ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Show Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; *6 months,* $2.50; *2 months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.80 (31 *shillings*); *Thin Paper Edition, One Year,* $6.31 (26 *shillings*). *SINGLE COPIES of any number in current Volume,* 15 *cents.*

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 323 *means that subscription is paid to the* 32d *week (that is the issue of Aug.* 6) *of the year* 1903; *the change of these figures is the only receipt, unless one is sent by special request.*

ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

The convention of the New England Water-Works Association, held at Boston last week, affords a good illustration of how a technical society may conduct its annual gatherings so as to make business the first object, and yet have no lack of that personal interchange of professional opinion and also that social intercourse which is so important a part of the life of such organizations. The convention occupied three days. There were three business sessions on each of the first two days, and when all the business had been transacted the members and guests took a most enjoyable outing over portions of the Metropolitan water-works which afforded as much instruction as any other feature of the convention.

One of the most notable facts about the New England Water-Works Association, and at the same time one of the very foundation stones of its success, is the manner in which it has secured the hearty coöperation of a large associate membership without sacrificing the dignity of the association. The associate members are heartily welcomed, and their exhibits are inspected and appreciated, but they do not dominate the time of the convention with excursions and entertainments, and when excursions are taken, or lunches or dinners served, each member bears his share of the expense involved.

The adoption of the standard specifications for cast-iron pipe, as submitted to the New England Water-Works Association by the committee whose report we printed last week, will doubtless be the beginning of better things in pipe, and therefore in water-works construction and operation. As was pointed out at the convention last week, cast-iron mains form the largest item of first cost in most water-works systems. If the truth were known, it would probably be found that defective pipes are one of the greatest causes of current expense, at least where water is pumped, on account of underground leakage. But whether the water is pumped or not, constant leaks and continual danger from breaks due to defective pipe, materially lessen the efficiency, and particularly the fire protection efficiency, of water-works plants, while of course the leaky mains hasten the day when additional supplies must be secured. The standard specifications, now adopted, will be, or should be, of immense value to small water-works which cannot afford, or feel they cannot, to keep pipe inspectors at the foundries, but of more importance will be their effect in a general raising of the standard of cast-iron pipe, a greater uniformity in the character and joint dimensions of the product, and, in the end, a cheapening of the material furnished. The foundries, as well as the consumers, will be great gainers in the end, a fact which probably all of them appreciate, though some have not yet grasped its full significance.

The work of another committee of the New England Water-Works Association deserves commendation, even though its final outcome may have been disheartening, as it certainly was disappointing, to its members. We mean the committee on private fire protection, which amicably agreed to disagree, submitted three divergent reports, and was "honorably discharged." It appears that the failure of this committee, in so far as it did fail, was largely due to two things: (1) It was composed of members whose interests at certain points were diametrically opposed, or at least were so regarded by the two main divisions; and (2) there was not enough of the spirit of compromise. This may be better appreciated after considering the composition and course of the committee on cast-iron pipe specifications. This committee consisted of three men who approached the problem from the same point of view, which was primarily that of the representative of purchasers of pipe. The other chief parties in interest, the foundrymen, were cordially invited to confer with the committee and to make suggestions. The foundrymen submitted counter-specifications and appointed a conference committee. The association committee took all these suggestions into consideration, together with those from other sources, and embodied in its final report all that, in its judgment, would tend to give the best pipe for a reasonable price. The private fire protection committee included interests not common to more than perhaps 1 or 2% of the membership of the association, so the water-works men, instead of conferring with the insurance interests, and adopting such of their suggestions as seemed to merit the adoption of the association, were confronted with a section of the committee as strong in numbers and as persistent in maintaining its tenets as the water-works men themselves. Under such conditions an agreement on all points would have been difficult, but a glance at the two reports leads one to feel that a compromise on some of them need not have been difficult. The final outcome of the controversy, for such it was, although in the best of spirit, was a happy one, for now there will be conference committees from the various interests involved, and if the several committees cannot agree on a joint report, each committee may be expected to agree among its own members and report its conclusions for adoption or rejection by the association from which it sprang. The unanimity and forcefulness of the report on this same general subject made by a committee of the American Water-Works Association last June (and reprinted in our account of the discussion on the New England report, elsewhere in this issue), shows what can be accomplished when water-works men alone attempt to deal with private fire protection.

A good illustration of the extent to which engineers are now employed is furnished by an announcement of the New York State Civil Service Commission that non-residents will be admitted to the examination of candidates for engineering positions, which is to be held on Sept 20. They are, it is true, somewhat handicapped, since it is announced that if three or more persons, who are citizens and resident, pass and reach the eligible list, they will be preferred over non-resid[ents] in certifying for appointments. It is said th[at] the reason for broadening the rules to admit [non-]residents to take the examinations was d[one] wise because so few applications from m[en] gible for the positions were received.

A second bit of evidence as to the dema[nd] for engineers is furnished in the current "employ[ment] bulletin," issued by the American Society o[f] chanical Engineers. The copy of this befo[re us] contains notices of 30 applications from em[ploy]ers and only 34 notices from men seeking p[osi]tions.

In our issue of March 27 last, we reviewed [at] length the different firms which are produ[cing] iron and steel in competition with the Un[ited] States Steel Corporation. A similar task has l[ate]ly been undertaken by the "Bulletin of the I[ron] & Steel Association," and it has summarized [sta]tistically the production of the independent [pro]ducers and that of the Steel Corporation. The fo[l]lowing table shows the percentage of total pro[du]ction of each class credited to the Steel C[or]poration:

Year 1901.	Percentage due to Steel Corporation.
Shipments of ore from Lake Superior	61.6
Total production of ore	43.9
Bessemer and basic pig iron	58.5
Spiegeleisen and ferromanaganese	65.4
Forge, foundry and other pig not included	3.4
Total pig, spiegeleisen and ferromanganese	42.9
Bessemer and steel ingots and castings	59.2
Open-hearth steel and ingots and castings	70.2
Total Bessemer and open-hearth ingots and castings	66.3
Bessemer steel rails	50.9
Structural shapes	62.2
Plates and sheets including black plates for tinning	64.6
Wire rods	57.6
All other rolled products	27.3
Total of all rolled products	50.1
Wire nails	46.8

Under modern conditions of railway track maintenance the section foreman is a man of considerable responsibility. The railways are finding considerable difficulty in procuring the right class of men for this work, as the pay of the track forces remains practically the same as it was several years ago, when foremen were obtained by promoting men from the section gangs. Under present conditions the service does not attract a high class of labor, and the section gangs cannot be organized as a permanent force, the cheapest possible class of labor being employed with the result that the gangs are largely composed of men who do not care for steady work or promotion, and are continually shifting from place to place. Those who might be competent to become foremen do not as a rule care to remain long in the track department, as they can obtain higher wages and better prospects in the train service or other work. A committee report on this matter was presented at the annual convention of the Roadmasters' and Maintenance-of-Way Association last week (as noted in another column), and led to a long and interesting discussion, in the course of which some of the speakers plainly stated that they would not know where to find really good and capable men to properly fill vacancies as track foremen. The two principal reasons for this difficulty are the general failure of the higher officers to realize the importance and responsibility involved in this position, and the consequent low rate of wages paid. A good section foreman, competent to meet the requirements of modern track service, is a skilled laborer, but he is not usually recognized as such. It has been many times suggested that the track department opens a field for engineering graduates, but as a matter of fact the pay and prospects are not such as to attract young men of this class.

Even where good and reliable men can be obtained for section foremen, another problem is that of educating them for the position, for it is certainly a most unsatisfactory method to let them pick up knowledge as best they can in their daily work as section men. Some years ago an officer of the Roadmasters' Association suggested the organization of apprentice gangs for the special training of men as foremen, but at that time the traffic and labor conditions were such that the idea was received with little respect. This

early suggestion was referred to in the discussion above mentioned, and there was quite a general opinion expressed that the most practical method of educating men for foremen would be to select bright, intelligent young men, and after explaining to them the possibilities and advantages of promotion in this department, to form them into extra gangs with a slight increase in pay. The extra gang would be under the direction of an experienced foreman, and would also be taken in hand more or less by the roadmaster or engineer. The gang would be employed particularly on work requiring skill, knowledge and judgment, rather than mere manual ability, and the men would also be instructed in the theory and practice of methods of laying out and executing work. The instruction would include switch and interlocking work, curve work, the handling of ballast and construction trains and crews, etc.; and would also include the necessary calculations and mathematics, and the keeping of those records and accounts. In this way there could be organized at small expense a body of reliable men, competent for the skilled and responsible work involved in the maintenance of railway track, and fitted to take charge of and direct the work. One of the essentials to success in this direction, however, is that a material increase be made in the present average pay of section foremen, or the men who are intelligent enough to be given this special instruction will be intelligent enough to see that their abilities will command higher remuneration outside of the track department. The average pay for foremen is $45 to $60 per month, which is entirely too small to command the abilities needed in such men at the present time.

ENGINEERS, CONTRACTORS AND SPECIFICATIONS.

What is a specification? What does or should an engineer do when he writes a specification for a piece of work? The work itself carries its own definition. To specify is to describe, definitely and particularly. The specifications of an engineer are or ought to be a definite and particular description of an engineering work. The writer of specifications which are to be used as a basis for the receipt of competitive bids, as nearly all specifications are used, should have a definite purpose in mind, viz.: to make clear to the prospective contractor exactly what is to be required of him. Only when this is done can the contractor prepare a bid for the performance of the work based on estimate and not on guesswork. If the specification does not do this, it is of no value and might as well be dispensed with.

The specification is the basis of the contract. It tells, or ought to tell, just what the contractor is required to do; and yet a valued correspondent of long experience in engineering work has just laid before us a communication which opens with the remark:

> A definition that would accurately define the greater number of specifications nowadays offered, would be "an instrument or document whose purpose is to set the contractor guessing at the meaning of the engineer."

Now if this indictment is true, why do engineers write such specifications? The reason, we think, is not far to seek. The engineer writes his specifications to fit—not the honest contractor who aims to do good work, and has a reputation at stake, but the dishonest and crooked one, who will scamp his work at every turn. The engineer knows that he may be obliged to let the work to a man of this latter class and he wants all the hold on him possible. If the specification leaves the engineer unlimited discretion as to the acceptance of work, he thinks he can better control the sharp contractor who seeks to take unfair advantage of every loophole in the plans or specifications.

This is the engineers' view of the case; but let us look at it from the standpoint of the honest and reputable contractor, who wishes to submit bids on such work, and also from the standpoint of the party who must pay for the work.

There is little need to say to the readers of Engineering News that even with the completest and most definite specifications, the contractor in most lines of engineering work has to take a large amount of risk. When the specifications are incomplete and indefinite, when everything is left to the judgment of the engineer, the contractor has often to reckon the personal equation of the engineer as the largest element of risk involved.

Is it not a mistake—let us consider the question candidly—to place any unnecessary burden of risk on the contractor? Is it not a self-evident fact that every such added risk means that a bidder who is financially responsible must add to his price enough to cover that risk? The irresponsible bidder has little to lose, and the result is that he too often submits the lowest bid. If he is lucky he makes a profit; but if luck goes the other way, the contract will probably be abandoned, and there will be the expense and delay attendant upon a reletting of the work. Nor is this the sum total of the evils of this method. From time immemorial the favorite scheme for corruption in connection with contract work has been through manipulation of specifications. Make the most severe specification that wit can devise, and it can all be defended as necessary requirements for the work. The contractor "on the inside" is aware that it will not be enforced, and can bid accordingly, and secure the work, since he knows what his competitors do not know, the "personal equation" of the engineer.

Taking all these things into consideration, is it not a fair statement that a specification should be judged by the extent to which it makes definite and clear the work to be done, so that the contractor can estimate beforehand with greatest certainty what financial obligations he is to assume?

There lies before us a specification for a new dry-dock for the U. S. Government, to be built at Charleston, S. C. It is a voluminous document of some eighteen closely printed foolscap pages, indicating that an effort has been made to actually specify what will be required of the contractor; and yet, judging by the standard just laid down, the specification is seriously defective in numerous particulars. The first paragraph of this specifications reads as follows:

> 1. INTENTION.—It is the declared and acknowledged intention and meaning to provide and secure a complete and substantial dry-dock in perfect working order, together with wing walls, quay walls, crane track, conduit, capstans, bollards, and all other needful appurtenances for the operation of same; excepting the pumping plant, pump well, and the caisson for closing the entrance, which are not included in this specification; all shall be as shown, indicated, or called for by the accompanying plans and this specification, except as provided in paragraph 3, and to the entire satisfaction of the Chief of the Bureau of Yards and Docks.

No one can take exception to this; but now let us read in connection with it paragraph 3, which we quote in full as follows:

> 3. OMISSIONS AND MISDESCRIPTIONS.—The omission from the contract or from the plans, specifications, or other papers attached thereto and forming a part thereof of any work or material required to secure the result set forth in paragraph 1, or the misdescription of any details of work, the proper performance of which is necessary to carry out fully the intention above expressed, shall not operate to release the contractor from supplying all such materials and performing such work, but the same shall be fully and properly supplied and performed in the same manner as if fully and correctly shown, described and required in and by the contract, and without expense to the United States in addition to the contract price.

We seriously doubt whether the engineer who drew this paragraph realized its full import; but unquestionably its effect is to make the contractor responsible for the engineer's design. In other words, the contractor must guarantee that when he has done the work described in the specifications and shown on the drawings, the result will be "a complete and substantial dry-dock in perfect working order."

Suppose the engineer *has* made a mistake. Suppose, for example, that he has made the floor of his dock of insufficient strength, or his cement specifications are not sufficient to furnish a concrete proof against the action of the sea water, or he has not made sufficient provision against leakage. When the dock is completed and put in service and such defects develop, the contractor can be called on to make the work good on the ground that he has not furnished the "complete and substantial dry-dock in perfect working order," which the contract calls for.

It is as if an engineer were to say to a contractor: "Here are the drawings and description to minutest detail of a pumping engine. I want you to build an engine according to these drawings and directions and guarantee that when it is completed it shall be a perfect working engine, capable of pumping 20,000,000 gallons of water in a day against 100-ft. head, with a fuel consumption of 1¾ lbs. of coal per I. HP. per hour." Of course if an engineer were to call for bids on such a specification he would be promptly informed by the builders of such machinery that they would not be responsible for the success of other people's designs.

We do not suppose, of course, that the Government engineers intended to ask the contractor to guarantee the success of their work. They simply intended, probably, to leave themselves a loophole by which the contractor would be obliged to furnish anything necessary to the work which they might have omitted to include in the specifications or to use different material from that which they had called for—all to the end of securing the best work in the end.

These intentions are praiseworthy enough, but how do they affect the contractor? He manifestly must estimate not only the cost of the material and labor which the specifications require, but must add to this estimate enough to cover the cost of other appliances or other materials which the engineer may call for. And if this is the case, is it not clear that a specification which places needless risk on the contractor is in the long run a most expensive one for the Government?

Looking further along in the specification we discover another evidence that the contractor must be prepared to suffer for the mistakes of the engineer. Under Section 25, the contractor is required to "check all plans furnished him immediately on their receipt" and also:

> the contractor shall compare all plans and verify the figures before laying out the work, and will be held responsible for any errors therein that thereby might have been avoided.

We are well aware that "it is human to err," as the old proverb has it, and engineers and draftsmen—as well as contractors—are subject to the failings of humanity in general; but why should the engineer throw the loss his errors may involve upon the contractor? Does not the checking and verification of drawings properly belong to the engineer?

Here again, we presume, the intentions of the engineer who drafted the specifications were good. He merely wished to place an added check upon the work to make sure that no error should creep in undetected; but he has overlooked apparently, the unfair burden which he is placing on the contractor.

Examining further the specification, we find other illustrations of the extent to which the contractor must place himself in the engineer's power.

Under paragraph 5, "Control of Work," we find the following:

> The United States, by its Civil Engineer in charge of the work or other authorized representative, shall at all times have full control and direction of all work under the contract.

While the engineer ordinarily has power to supervise the work, he is limited to seeing that it is carried out in accordance with the plans and specifications. No such limitation is found in the above clause. The civil engineer if he chooses has the right to take charge of all operations, handle the men and carry on the work as if it were his own. Between the control of the engineer and the restrictions of labor unions there would not appear to be much left for the contractor to do but pay the bills for labor and material, look pleasant, and patiently wait for such profits—or losses—as may finally result. Oh, yes, we had forgotten. He has the work of checking the engineer's drawings, above noted, and also under paragraph 24, he is required to "submit the necessary detail plans for all portions of the work to the civil engineer in charge for approval before proceeding with the work." In other words, the engineers of the Government have not made, and are not to make, details of the entire work for the contractor's guidance. He is to make any such further plans as may be needed and not as rough sketches, either—such as foremen often make to exhibit to engineers—but as "tracings on cloth of Bureau of Yards and Docks standard sizes."

An interesting paragraph to the prospective bidder is that which describes the chance which he runs of having the contract taken from him. We quote this in full:

> 15. PROGRESS OF WORK.—If at any time the progress of the work shall, in the opinion of the Civil Engineer in

charge, appear to have been such as to indicate that the work is not likely to be completed within the time allowed, he shall report such opinion to the Chief of the Bureau of Yards and Docks, who may, in his discretion, declare the contract null and void, without prejudice to the right of the United States to recover for defaults therein or violations thereof.

It is common enough, of course, to provide in specifications for the cancelling of the contract if a certain rate of progress is not attained. This is the first time, however, that we remember to have seen a cancellation of a contract made solely dependent on the opinion of the engineer in charge.

Changes in the contract, plans or specifications are provided for in paragraph 17. For all such changes which affect the cost of the work, either to increase it or decrease it, the contractor is to be compensated or mulcted, as the case may be, in the following manner. If the amount involved is less than $300 the estimate is to be made by the engineer-in-charge. If it is more than $300, the estimate is to be made by a Board of not less than three officers appointed by the Chief of the Bureau of Yards and Docks. In either case the basis of the estimate is to be the actual cost plus a profit of 10%. The contractor's bill for "extras" has been always a fruitful source of contention, and the engineer who drafted this specification doubtless intended to guard against losses on that score. He has, however, unquestionably gone too far in the other direction. We see no reason why the contractor should not be allowed equal representation on any board set to determine the value of work done by him.

It must be clear from what has preceded that it is an exceedingly important matter to the contractor on this work what sort of a man the engineer over him is to be. Will he be a practical man or a theoretical stickler for hair-splitting refinement? As many contractors know from sad experience, insistance on refinements and limits of accuracy in the performance of work often increase its cost out of all proportion to the final result obtained. Naturally then, prospective bidders on this work will scan carefully the specified methods of doing work to see what evidence they may find of hair-splitting requirements. Turning to the specification for piling we find the following:

> The heads of piles shall be cut off level at the exact elevations shown on plans; concave, convex or inclined heads will not be allowed, and when so cut off shall be recut in proper manner.

These piles, it is to be borne in mind, are to be imbedded in solid concrete without capping. What earthly difference does it make to the safety of the work, therefore, whether the piles have exactly square heads or are cut as the ordinary machine saw leaves them?

Turning to the specification for pile-driving, we find that piles are to be driven until "the average penetration per blow for the last five blows shall not exceed 1½ ins. with a 3,000-lb. hammer falling freely 20 ft." It is also stated to be the intention that the maximum load per pile shall be 15 tons. Computing the safe load for piles driven with such a weight and fall by the well-known "Engineering News formula," we have:

$$\text{Safe load} = \frac{2 \times \text{weight of hammer, lbs., } \times \text{ height of fall, ft.}}{1 + \text{av'g penetration in inches; last few blows}}$$

or

$$\text{safe load} = \frac{2 \times 3{,}000 \times 20}{1 + 1\frac{1}{2}} = 48{,}000 \text{ lbs.} = 24 \text{ tons.}$$

If this specification were modified to conform to the above formula, the height of fall would be reduced to 12 ft. 6 ins. We submit as a practical question to those experienced in pile-driving whether the injury to piles driven with a 3,000-lb. hammer falling freely 20 ft. would not be more of a detriment to the stability of the work than the theoretical increased bearing power due to the greater fall.

In considering the risk taken by the contractor, it is to be borne in mind that his bid for the work is required to be, not a bid on unit prices—so much per yard for excavating, so much per foot for piling, etc.—but a lump sum for the entire work. He is required to build a dry-dock, to guarantee its completion and perfect working, and yet he is explicitly denied the authority to say how it shall be built.

The question is a pertinent one: Do the engineers of the Bureau of Yards and Docks or the contractors know better how to build a successful dry-dock? If the contractors have such special knowledge, then give them the responsibility for the methods of working, and hold them only to a successful final result. If the engineers have this knowledge, know exactly what they want and how they want it done, then they should specifically describe the work and let the contractor's responsibility end when he has performed this work in accordance with the plans and specifications. But it will be said, we presume, that the work is too uncertain and subject to too many variations that arise during its progress to permit making a definite specification. If this is the case, then withdraw the call for bids, and carry out the work by day labor.

We believe it is a fact which deserves more consideration by the engineering profession, and especially by those who frame laws to control the performance of public work, that all classes of work are not suitable to be done by contract. It would be to the public advantage if contract work were confined to work that can be clearly and definitely set forth in plans and specifications and that involves no element of large and unknown risk.

LETTERS TO THE EDITOR.

Progress of the Insurance Engineering Experiment Station.

Sir: We are very glad to see so full a report of our tests of fireproof wood as that which you gave in a recent number (Sept. 4). It might be judicious for you to say that we were not entirely satisfied ourselves with these tests of small pieces, because in the laboratory we could not measure the importance of the slightly decreased flammability of the prepared wood, as compared to the effect of intense heat from a neighboring fire. You will remark that we refer to that in our report, and to plans for making a final test by which that point will be decided. We now have land offered at our disposal on which to put up concrete and other buildings. As soon as one can be completed the opportunity will be given for the representatives of fireproof wood, of alignum, Sackett plaster board, of the Keasbey & Mattison building lumber, of uralite, of monolith, and of the material furnished by the Art Metal Co., and other substitutes for wood, now becoming very numerous, to put up molding, doors, window frames, dadoes, ceilings or anything else to suit themselves. We will then put them to the test of flammability; of the combustion of contents; and finally to a heat equal to the melting point of cast iron, generated by oil fuel. In that way we may reach a much more conclusive result than can now be obtained in the ordinary laboratory.

I may also add that while we can get no information subject to a citation of witnesses belonging to the Navy Department, yet we have every reason to believe that much of the fireproof wood that has been put into naval vessels has been removed, and that a very bad fault of molding and of the corrosion of the steel by contact has in part led to this change in policy. We are developing fungus in chemically-treated wood, but it requires lapse of time.

Yours very truly,

Edward Atkinson,
Director Insurance Engineering Experiment Station.
31 Milk St., Boston, Sept. 9, 1902.

Primary and Secondary Considerations in the Disposal of Sewage.

Sir: I observe that considerable comment of a scoffing character is appearing from time to time in your columns and elsewhere, upon the somewhat crude criticisms of the daily press—the Boston "Transcript" and Brooklyn "Eagle," for instance—of present practice in regard to sewage disposal. It is quite true that the tone of some of these criticisms invites the "retort discourteous," but I think that an account should be taken of the element of truth which these papers have caught hold of.

The trouble with the papers referred to is the drawing of hasty conclusions from misunderstood data, and confounding primary objects with secondary ones. It is characteristic of the dilettante that he seldom stops to ask why an obviously good thing to do in connection with any work is not done by the experts having the matter in hand. It does not occur to him that the very obviousness of the proposition proves that there is an obstacle which he does not perceive to its execution, and he forthwith concludes and asserts that those who have made a life study of the subject are densely stupid because they fail to do what it is so clear to him that they should do.

The primary object of sewerage is to remove all household wastes from contact with human beings as rapidly and completely as possible, with a view to promote health and comfort, to reduce the spread of preventable disease and lower the death rate. In a seaboard city, or one situated on the banks and near the mouth of some mighty river, the best way is to at once discharge the whole of the output into deep water. If it were possible to macerate it all up, like garbage, this would be still better from a purely sanitary point of view. When deep water disposal is impossible, the alternative is purification, and here is where the battle opens. The sanitarian says there is nothing for the possible commercial value of sewage for manurial purposes; it is a menace to health and must be got rid of as quickly and completely as possible." The dilettante economist replies: "Get rid of it, certainly, but do not throw it away; use it to advance crops." This is the exact point upon which he needs enlightenment. The processes necessary for quick removal of sewage disqualifies it as a fertilizer, and to convert a purification plant into an efficient manure factory would necessitate processes disqualifying it for its main object.

The sanitary engineer knows quite as well as the daily-paper editor the value of the products he is so anxious to get rid of. He practices sewage irrigation where conditions permit, and he is ever on the alert to realize methods by which waste products can be made use of without interfering with the primary objects he has in view. Indeed, the irritation which crude newspaper criticism causes the engineer is perhaps partly due to the fact that it seems a taunt to his inability to accomplish that which he is frank to admit would be very desirable if practicable. In the meantime the public will prefer to leave the matter in the hands of the engineers rather than of the editors, and in the present state of the science the former are convinced that the best use you can make of sewage is to throw it away.

E. Sherman Gould.

Yonkers, N. Y., Sept. 12, 1902.

(Aside from the intimation, or allegation, that our recent comments on certain daily newspaper editorials have been of a "scoffing" and "discourteous" character, our correspondent's remarks virtually restate and endorse the comments made in our issue of Sept. 11. A careful reading of the notes in that issue would convince him, we believe, that instead of scoffing at the daily press we first pointed out and then apologized somewhat for its limitations.—Ed.)

Locating the Center of a Section and Subdividing Land Below a Meander Line.

Sir: Section 2,396 of the revised statutes of the United States starts out as follows:

> The boundaries and contents of the several sections, half-sections and quarter-sections of the public lands shall be ascertained in conformity with the following principles.

Then follow the principles, one of which is:

> The boundary lines which have not been actually run and marked, shall be ascertained by running *straight lines* from the established corners to the opposite corresponding corners.

How lines having angles and jogs in them, as proposed by Mr. Kern in your issue of Aug. 28, can be in conformity with that principle I am too dull to comprehend.

Commissioner Wilson, of the General Land Office, said (Dunn's Land Laws, p. 19):

> The manner of subdivision consists of measuring *straight lines* from quarter-section corners of a particular section to the opposite corresponding corners and the point of the intersection is the interior corner common to four quarter-sections.

I can understand that method to be in conformity with the principle laid down in the law. But to justify a different method we are referred to clause third of the same section of the statute, in which it is said:

> The half-sections and quarter-sections, the contents whereof shall not have been thus returned, shall be held and considered as containing the one-half or the one-fourth part respectively of the returned contents of the section, etc.

As it looks to me, if Congress had intended to override and abrogate the principle which it had previously laid down, it would have said plainly these half and quarter-sections *shall contain* the one-half or the one-fourth part, etc. But it did nothing of the sort. Just as it said in regard to measures in clause second, "the length of such lines as returned shall be held and considered the true length thereof," so, in clause third, it says these half and quarter-sections "*shall be held and considered as containing* the one-half or the one-fourth part," etc. That is in harmony with the rest of the act and a very different thing from saying they *shall contain* such a part of the section. The whole act shows evidence of the design of Congress to supersede the common law rule in fixing the boundaries of half and quarter-sections, otherwise it would have said nothing about it. There would have been no need to require us to "hold and consider." But Mr. Kern tells us that after all it is for the state courts to settle and that they follow the common law rule. I question the correctness of the latter part of this statement. So far as my reading goes, it is the rare exception for a state court to uphold a different method of subdividing a section from that provided in the statute under which land-holders acquire their rights.

According to such light as I have had, it is not even good common law, where landed rights have been at-

uired under the provisions of and in accordance with e statute, for the common law thereafter to step in and tempt to vary those rights.

Mr. Kern says in reference to the standard of measure at in his work as U. S. deputy surveyor he never used saw used a Gunter chain. If he and others *had* used e Gunter chain they would have saved themselves the uble of changing feet into chains and links in their urns and would have saved the Interior Department necessity of forbidding the use of the engineer's chain the public land surveys, as has been done on p. 22 of Manual of 1902.

In regard to subdividing land below a meander line, Kern, in your issue of Sept. 11, refers to the Michi- case of Clute vs. Fisher, in which it was held to the t that the boundary lines extended under the water same as if there were no water there and never had This is an isolated case in the Michigan decisions. pplies to that case alone. In Jones vs. Lee and the se of the Grand Rapids ice companies and other cases, e Michigan court adheres to the common law rule of parian ownership.

F. Hodgman.

Climax, Mich., Sept. 12, 1902.

Construction Work on the Mexican Central Ry.

Sir: The following are some notes regarding construction work on the Mexican Central Ry. in Mexico:

On the line from San Pedro to Paredon, a distance of 221 kilometers or 137.3 miles, the contractors, Hampson & Smith, are employing about 2,000 men and a large number of teams. Track has been laid 26 kilometers, or 16 miles, from San Pedro east. This entire line should be finished by June 1, 1903.

San Pedro is in the district where most of the Mexican cotton is produced. Many new industries are developing about Torreon, Palacio and Lerdo, which towns are connected by an electric railway of first-class construction and elegant equipment. Lerdo and Palacio are in the state of Durango, while Torreon is in the state of Coahuila. This electric railway is about eight miles long, connecting each town, the smelter, and most of the industries. Each state is exerting itself to build up its respective towns and doing all in its power to secure other industries to locate in its territory. This large growth of business started first from the cotton district; cotton factories, then enormous soap works, cotton-seed oil works, glycerine factory, chemical works, smelters, brewers' cold storage, electric light plants, and all the lesser industries which are required in a civilized, progressive community. The railways are not slow in providing facilities for the present business, and preparing for a constant increase.

The Mexican Central Ry. is preparing to take the mineral products of northern Mexico, which naturally comes to Torreon either as ore or concentrates, and haul them to Monterey or Tampico. Their new line gives them 290 kilometers from Torreon to Paredon on a 3.10% grade for trains going east, and trains going west have 60 kilometers of 1% grade out of Paredon to Jaral, then 229 kilometers of 3.10% grade into Torreon. The maximum curves are 6° on 100-ft. chords. There is one tangent on this line 71 miles in length. Artesian wells are being put down along the line and water of good quality has been found 57 kilometers east of San Pedro.

On the line north of Paredon there are four locating parties under G. A. Andreen, W. F. Waters, Edward Stalter, and W. C. Simmons respectively. Two of these parties have crossed the line into Texas, looking for a connection somewhere in the United States.

On the direct line between the City of Mexico and Tampico, the Mexican Central Ry. Co. has five locating parties, in charge of Asst. Chief Engr. C. W. Curry, the locating engineers being A. H. Long, W. O. Galbreath, E. C. Torrence, E. G. Wagner and J. A. Card. Seventy kilometers of this line are under construction by Bell & Semmes, and will be finished soon after Dec. 1 next; also a short branch to Pachuca, 16.70 kilometers long, giving the Mexican Central Ry. the shortest line between the City of Mexico and Pachuca.

Work on the new line between Tuxpan and Colima, 63 kilometers, was let to Hampson & Smith on Sept. 6, for the grading, tunnels and masonry. This contract will amount to about $3,500,000 Mexican silver, and is to be completed in 26 months. This line was located first by Chas. W. Curry, who commenced the first location March 1, 1899, and completed it in January, 1901. Since then O. G. Bunsen has spent one year making changes, throwing out adverse grades and improving the bridge crossings. Mr. Bunsen is still at work on these changes. Edward Wright is in charge of the first division and the first tunnel on this work. The maximum grades on this line are 2% compensated, and the minimum curve is 9° on 100 ft. chord, and there are 13 tunnels and 17 large bridges. A. J. Tullock, M. Am. Soc. C. E., of Leavenworth, Kansas, has been employed to take charge of the bridge work. It is expected that the line will be open for traffic by Jan. 1, 1905. The Mexican Government is spending several million dollars on the harbor improvements at Manzanillo, and when this line is open for business Mexico will reach out and develop its coast country.

L. W. Miller, in charge of a locating party, commenced in March, 1901, and has been locating the line from San Marcos to Compostela ever since, and he will reach Tepic in about two months. H. F. Howe, with a locating party, is working in the state of Zacatecas.

There are twelve locating and eight division parties in the field at the present time, and other parties are being organized.

Lewis Kingman.

City of Mexico, Sept. 10, 1902.

Notes and Queries.

Referring to our note in the issue of Sept. 4 on the heavy average train load hauled on the Chicago & Eastern Illinois last year (629 tons, including company freight), we are informed that a very much higher record was made on the Pittsburg & Lake Erie R. R., in the year ending June 30, 1901, when the average freight train load was 758 tons.

THE AMERICAN-ASIATIC STEAMSHIP CO. has been organized, with Wm. Barclay Parsons, M. Am. Soc. C. E., and Chief Engineer of the New York Rapid Transit Railway, as President. Among the directors are August Belmont, Cornelius Vanderbilt and representatives of Keuntze Bros., Vermilye & Co., and Brown Bros. The sailings will be monthly from New York, and the first vessel of the line, the "Gibraltar," will probably sail in October. The general agents of the line in the Orient will be Messrs. Shewan, Tomes & Co. The vessels will call at Singapore, Manila, Hong Kong, Shanghai, Nagasaki, Kobe, Moji and Yokohama. The New York headquarters are at No. 16 Beaver St.

THE NUMBER OF STEAM ROAD ROLLERS manufactured in the United States in 1900, according to a recent census bulletin, was 130, valued at $345,881. These rollers were all made by eight establishments, located in New Jersey, New York, Ohio and Pennsylvania.

GERMAN EXPORTS OF LOCOMOTIVES are growing, says U. S. Consul J. J. Langer, of Solingen, Germany. Orders have recently been booked by German manufacturers for 100 locomotives to go to Siam, Italy, India and Denmark; they are valued at about $1,500,000. The German machinery export trade has decidedly decreased during the past year, but the export of locomotives and traction engines in the years 1899, 1900 and 1901 amounted to $2,689,400, $3,736,600 and $5,259,000, respectively. In the figures for 1899 and 1900 traction and passenger cars and motor wagons are included, to the value of nearly $800,000.

GERMAN LOCOMOTIVES have been ordered to the number of 32 by the East Indian Ry. The prices bid are said to be 20% lower and the time of delivery 25% shorter than the best English bid. The price quoted is given by the "Indian and Eastern Engineer" as £2,612, complete with tender, delivered at Calcutta, or $12,668. The weight is not given, but the engines are to run on the Indian broad-gage track of 5 ft. 6 ins. The contract is held by the firm of A. Borsig, of Berlin. Another Indian railway, the Bombay, Baroda & Central India, has purchased 22 tank engines of the Berlin Machinery Co., its bid being £27,300 less than the lowest English bid, and the time of delivery 28 weeks less.

THE RAILWAYS OF CAPE COLONY (South Africa) had a length of about 2,722 miles at the end of 1901, and as a result of the necessary postponement of repair work owing to military requirements, very heavy expenditures were incurred last year, and have still to be incurred, for repairs to works, track, locomotives and cars. The precarious character and bad quality of the water supply along the lines has led to the use of some American deep-boring Sullivan drills in exploring for new supplies. Progress has been made in erecting signals and putting in interlocking plants, and automatic electric signals are to be erected for experimental purposes. The work of reducing grades and curves and relaying the main tracks with 85-lb. rails is gradually progressing, as well as the extension of double track. In the locomotive department, the principle of standardization has been carried out to a considerable extent. All main line traffic is worked by six-coupled and eight-coupled engines, which are duplicates, except for the American engines. The two American (Schenectady) consolidation engines put to work in March, 1901, have "fully answered expectations," according to the report of Mr. Beatty, Chief Locomotive Superintendent; 14 similar locomotives have therefore been ordered. Freight cars with steel underframes are gradually superseding these with wooden frames, but as large parts of the lines are laid with 45-lb. rails the maximum carrying capacity is recommended as 15 tons for four-wheel cars and 30 tons for eight-wheel cars on trucks. Mr. Brown, the Engineer in Chief, reports that the ties are being so badly cut by the rails that the desirability of introducing tie-plates must be seriously considered. The railways are of 3 ft. 6 ins. gage, but some pioneer lines of 2 ft. gage have been commenced. They are all owned and operated by the government through a Commissioner of Public Works and the General Manager of Railways, Mr. T. R. Price.

ONE CAUSE OF LEAKY LOCOMOTIVE FLUES *

By S. W. Miller.†

It will doubtless be admitted by all who have had personal experience with locomotive flues in bad water districts, that the causes of leaky flues are numerous. Those who have not had the rather doubtful pleasure of reading detention reports in which the cause is given as "leaky flues" are, I believe, largely in the minority in this section of the country. Of course the primary cause is bad water. Were this removed, our troubles would be practically at an end.

The mileage made by a set of flues varies much at places within even 200 miles of each other. Yard engines in one of our yards averaged during the last five years, between flue settings, 17,475 miles; at another yard less than 200 miles distant from the first, the average mileage for the same period was 41,278 miles. The water at the first yard averages about 36 grains of scale-making material per gallon; at the second one about 14 grains.

It is very difficult to show by figures that it is cheaper from a motive-power standpoint to purify the water than to reset flues. When I say purify, I mean to reduce the scale-making material in the water to about three grains per gallon by chemical means, and before the water is put into the locomotive tank, although this is, in the opinion of those who have carefully studied the subject, the only proper way to get good water. Most of us are unfortunate in not having a pure water supply, or water that has been purified. It therefore remains to do the best we can under conditions that are frequently adverse.

The committee of the Master Mechanics' Association which reported in 1901 on the subject of "The most satisfactory method of handling, cleaning and setting boiler tubes," found that the practice of 27 roads was practically uniform as far as setting the tubes was concerned. The report was quite fully discussed, but there was one point brought up which did not receive the attention which I think it should have. There was one other point which was referred to indirectly, but which did not attract any attention. The first of these points is in regard to the roundness of the holes in the flue sheet; and the second one is in regard to the shape of the section of the hole.

There will be no argument, I believe, against a round hole; as to whether it should be cylindrical, there are differences of opinion. It is very expensive to ream the holes in a flue sheet as soon as they become slightly out of round. The width of the bridge between the flue holes would become too small and it would be necessary to apply a new flue sheet, which takes both time and money. The question recently arose on our road as to when the holes in the flue sheet should be reamed. The opinions of those interested varied materially; the extremes being that one man would ream the holes when there was 1-64-in. difference between the long and short diameters of the holes, and the other would wait until this difference became 3-32-in. My personal opinion was between the two. After considering the subject carefully, I thought that 1-16-in. difference between the diameter would do no harm.

It became necessary, of course, to get some facts bearing on this matter and we made several tests to determine what the action of the tools ordinarily used in setting flues had on the flue sheet. A careful examination of a large number of flue sheets shows that in every instance the holes in the upper corners of the flue sheets are oblong. In one case, there were 7 holes 3-32-in. out of round, 11 holes 1-16-in., 37 holes 1-32-in., 54 holes 1-64-in., and 34 were round. This flue sheet was not in bad condition and the flues could have been reset and would have given very good results since the holes that were badly out of round were in the upper corners, as above stated, while the holes that were true were in the bottom center part of the flue sheet, where flues always give trouble first. We reamed the holes in this sheet and again carefully measured them, to see if there was any spring in the sheet which would cause them to become oblong after they had been reamed. We failed to find any evidence of any such action. We then selected two holes, one in the center of the sheet and one in the upper left-hand corner. In these we set flues, following our regular practice. The flues were then cut out, and the holes again measured. It was found from these tests that while the holes were originally round, yet the work of setting the flue has made a difference in some cases of 3-100-in.

We next took a flue sheet in which the holes were oblong, and made the same tests as above, except that all the holes were measured, first while the flue was in place, so that the diameter of hole is the inside diameter of the flue after rolling, and second, that the holes were again measured after the flue was cut out and the piece of the sheet enclosing the seven holes, sheared out. The difference between the long and short inside diameter of the flues is less than the difference between the same diameters of the holes in which they were set, showing that the flue setting tools will take care of quite a little variation in the diameter of the holes in the flue sheet. It also appears that there is some stress produced in the flue sheet by expanding the flues, which is partly relieved when the piece in which the flue has been set is cut out.

*Abstract of a paper prepared for the meeting of the Western Railway Club, held in Chicago on Sept. 16.

†Master Mechanic; Pittsburg, Cincinnati, Chicago & St. Louis Ry., Indianapolis, Ind.

We made two more tests to confirm the above results in still another flue sheet. It was found that the direction of the long diameters frequently changed, and that the flue sheets move in an irregular manner under the influence of the expanding tool. The general tendency, however, is for the holes in the upper corners to become oblong, the long axes being parallel to lines drawn from the top center of the flue sheet at an angle of 45° below the horizontal.

As above stated, flues in the upper corners, even those set in oblong holes, give very little difficulty from leaking, while those in the center and bottom of the flue sheet, are the ones that cause the trouble even although they are practically round. An examination of a large number of flue sheets showed that the holes in the bottom center part of the sheet, while they were round, or nearly so, were not cylindrical, the diameter of the hole next to the firebox being from 1-64-in. to 3-64-in. larger than on the side opposite. Neither were the holes conical, but of irregular shape. Upon looking over the records and questioning everybody concerned, it developed that the engines which had given the most trouble from leaking had the worst holes in this respect. This appeared then to be the key to the difficulty, and in searching still further, it was found that the trouble was caused in all probability, by the use of taper mandrels or drifts, which being forced into the straight holes in the flue sheet, temporarily stopped the leaking, but permanently injured the flue sheet. These, of course, were removed as soon as it was discovered that their use was detrimental, and the Prosser expander substituted. A noticeable improvement was found almost at once.

It would appear from the above tests and experiments that it is useless to ream a hole in a flue sheet which is less than 1-16-in. out of round, provided it is cylindrical; but that if there is over 1-32-in. difference between the diameters at the two sides of the sheet the hole needs reaming, even although it is round. I do not claim that attention to these two points will stop the trouble from leaky flues, but I know that by watching them carefully, and reaming the holes at the proper time, the trouble will be reduced and I believe without any decrease in the life of the flue sheet.

REPORTS OF COMMITTEES OF THE NEW ENGLAND AND THE AMERICAN WATER-WORKS ASSOCIATIONS ON PRIVATE FIRE PROTECTION.

One of the most bothersome problems confronting water-works officials is how to handle the private fire protection services of factories and other industrial establishments requiring more protection than is afforded by street fire hydrants. These private services may involve a system of yard pipes and hydrants, or an automatic sprinkler system, or a combination of the two. The water actually used for fire protection is of little consequence, but the additional construction expense is sometimes an important item, and, most troublesome of all, as nearly every water-works man of experience stoutly maintains, water is surreptitiously taken from these private fire services and used for other purposes. Besides all this, leaks and broken pipe must be contended with.

Some time ago the New England Water-Works Association appointed a committee to investigate "The Apportionment of Charges for Private Fire Protection, and Means of Controlling the Supply Thereto." After some changes and additions the committee finally consisted of seven members, three of whom are water-works superintendents, three connected with the engineering or inspection departments of fire insurance companies, and one a civil engineer, who has been a water-works superintendent, and is now largely interested in a manufacturing plant. This committee was scheduled for a report at the meeting of the association in Boston, last week, but made three reports instead, representing the three sections just named.

REPORT OF THE WATER-WORKS SECTION OF THE COMMITTEE.

Messrs. F. H. Crandall, C. E., of Burlington, Vt.; Chas. K. Walker, of Manchester, N. H.; and J. C. Hammond, Jr., of Rockville, Conn., superintendents of water-works at the places named, reported so briefly that their conclusions may be given in full, as follows:

That we find the opportunities for taking water without the knowledge of the water department afforded by the presence of private fire pipes are frequently taken advantage of.

That furnishing private fire protection merits compensation.

That the compensation, however, should not be such as to discourage the use of automatic sprinkler systems.

That securing assurance of the use of private fire pipes for such purposes, only, is a matter of small expense, and may reasonably be required.

We would recommend, provided trustworthy evidence in regard to the service and reasonable remuneration for the protection afforded be furnished, such applications for private fire services as will not unwarrantably jeopardize other interests, be granted.

REPORT OF THE INSURANCE SECTION OF THE COMMITTEE.

Messrs. Byron I. Cook, of Woonsocket, R. I. (formerly superintendent of water-works there), Henry A. Fiske and Edward V. French, both of Boston, together representing both the mutual factory and the stock insurance interests, opened their report as follows:

Taking the country at large, water is taken somewhat frequently from private fire pipes for manufacturing and miscellaneous uses without the knowledge of the water department. The majority of such takings are not with deliberate intent to defraud the water department, but from a lax view of the rights in the case. Instances of intentional stealing, even to the extent of making concealed taps, are, however, not uncommon.

The committee then stated the advantages which private fire protection affords to the public through lessening all the injuries to a community incident to the destruction of a manufacturing industry, and also by decreasing the liability to general conflagrations. The private fire service should be regarded as but an extension of the general fire protection afforded the public, and therefore should be as free as the latter, "provided that absolute assurance is secured that the water is not used for any other purpose." The extent to which those directly benefited should pay for private fire protection was thus stated:

Plants having private fire protection should pay all cost for such equipment, all the first cost for connecting to the public mains, and a yearly charge ample to reimburse the public water department for all reasonable supervision of their fire pipes, such as to read and keep in repair any detecting devices which may be provided, and any other similar expenses.

As to the various means of making sure that private fire services are used for no other purpose the report stated that ordinary meters are unsatisfactory "from the possibility in many types of serious obstruction to the flow," and because the "large size meters are not sufficiently sensitive to detect the smaller drafts." Seals, to be broken when necessary, and to result in a penalty when their breaking cannot be satisfactortily explained, give "considerable protection, but are not positive safeguards, and require constant supervision." The general extension of seals would not be favorably regarded by the fire underwriters, because it would tend to lessen the efficiency of the private fire brigades.

Meters on ⅝-in. by-passes can be quickly applied without warning, and their further use seems to have possibilities worthy of consideration.

In conclusion, it was suggested that a committee be appointed to report on "means whereby assurance may be had that private fire pipes are used for fire purposes only;" also, that the new committee confer with the American Water-Works Association and the National Fire Protection Association.

REPORT BY MR. JOHN C. CHASE, M. AM. SOC. C. E.

Mr. Chase, of Derry, N. H., submitted a brief report. Water is doubtless taken without being paid for, but such action is due to low moral standards regarding public water supplies rather than to premeditated larceny. He thought all the expense of construction, and also of devices to detect the wrongful use of water, should be borne by the water consumer. Unlawful users of water should be deprived of water altogether.

GENERAL DISCUSSION.

Mr. W. Paulinson, of Passaic, N. J., said that he had found the use of meters on private fire services satisfactory. Inasmuch as his works is owned by a private company, and the city is charged for fire hydrants, it is necessary to charge for private service in Passaic.

Mr. Allen Hazen, M. Am. Soc. C. E., of New York city, thought the evil of stealing water a serious one, for while the subject comes to his attention only incidentally, yet he hears of it very frequently.

Mr. W. C. Hawley, Assoc. M. Am. Soc. C. E., of Wilkinsburg, Pa., said he noticed that the committee refrained from using the word steal, which it appeared was none too strong to express the facts in the case. He described an automatic valve devised by Mr. W. A. Alexander, of Wilkinsburg, and which is mentioned twice below.

Mr. Frank C. Kimball, of Knoxville, Tenn., said that where water-works are owned by private companies some charge for fire service must be made. His company gives all its regular consumers fire protection without extra charge. Where owners of manufacturing plants are not always cognizant of stealing, connections being made to fire lines by employees for their own convenience, the Knoxville Water Co. uses a metered by-pass of the same size as the fire supply. The gate on the main pipe is normally closed and the regular supply passes through the meter. In case of fire the gate is (automatically?) opened. Tests of such meters have shown that a large proportion of the water passed, even in the case of small leaks, is registered.

Mr. R. C. P. Coggeshall, of New Bedford, Mass., stated that leakage through private fire pipes had been found to be considerable, which, of course, suggests another reason for metering all such services.

Nearly all the members of the committee took part in the discussion, but for the most part only restated or elaborated the reports previously submitted. Mr. French thought that inasmuch as other private buildings are given fire protection from the street hydrants without charge, there should be no special tax on such manufacturers as wish to put in automatic sprinklers or any other fire-fighting devices superior to what the municipality provides. He was afraid that the Alexander device would not meet the approval of the underwriters, his reason being, apparently, that it was not thoroughly automatic.

Mr. F. H. Crandall read a committee report on the same general subject submitted to the American Water-Works Association last June, and printed in the recently published proceedings of that organization. This report is particulary interesting, since it was made by a committee composed of water-works men only, and covers practically all the points at issue in the New England committee of mixed membership. The members of the committee were as follows: Messrs. Geo. H. Felix, President Water Board, Reading, Pa.; C. E. Bolling, Superintendent, Richmond, Va.; C. H. Campbell, Superintendent, Charlotte, N. C. The latter is now president of the American Association. The report was virtually in the form of a series of resolutions, which were adopted by the American Association, as follows:

REPORT OF AMERICAN WATER-WORKS ASSOCIATION COMMITTEE ON REGULATION AND CONTROL OF PRIVATE FIRE SERVICES.

Your special committee appointed to consider and report upon the question of the control and regulation of private fire service begs leave to report and recommend

That it be the sense of this association, that the following regulations should be enforced:

(1) That all applications for attachments to street mains for private fire service, be accompanied by a draft or plan of the proposed pipe system intended to be used on the property to be protected, together with a concise statement as to what other purpose the system might be used for.

(2) That upon approvel of the application by the proper authority, its construction shall be such as to insure an accounting of all water used. Meters for this purpose to be installed and used.

(3) That by reason of the additional protection received by the property owner and because of the risk entailed upon other portions of the supply lines in case of a fire, it is eminently fair and just that there be made an equitable charge for every private fire service.

(4) That the objection of fire insurance companies to the use of water meters on private fire service attachments is not well founded and should be opposed by the managers of water-works systems.

(5) That all expenses incident to the installation of private fire service attachments, including cost of meters, be borne by the applicant or owner of the property.

(6) That the size of the openings for attachments shall be such as the engineer or superintendent shall find adequate, keeping in view, when deciding the question, the requirements necessary to properly protect other property on the same supply lines.

That to avoid surreptitious use of the water, devices be adopted by the superintendent and engineer to detect same, and in this connection we call attention to that of Mr. Alexander, of Wilkinsburg, Pa., as an example, and of which we will present a plan to the association.

FINAL ACTION OF THE NEW ENGLAND WATER-WORKS ASSOCIATION.

The three reports were finally accepted and ordered printed. Later, there was an attempt to secure the adoption of the report made by the water-works section of the committee, but instead of so doing the president was instructed to appoint a committee of three members, all water works men, to give the subject further consideration, and to confer with other associations representing the water-works and the insurance interests. A motion that the old committee be "honorably discharged" was received with laughter and was unanimously carried.

THE CARE OF LOCOMOTIVE AND CAR SCRAP.*

By T. A. Lawes.†

The economical assortment and disposition of scrap at locomotive and car shops has been pursued on widely varying plans. One of the most primitive methods is to bring the scrap to some convenient place and throw it unassorted on the ground. It is then assorted when loaded for shipment to purchasers. It is wheeled to the cars in barrows and lifted up to the floor by "main strength," and laborers in the car transfer it by hand and wheel barrows to ends of car.

To supplant such methods a scrap bin was constructed several years ago, which may prove of interest, and which is shown in the accompanying drawing. In it is handled the scrap from the locomotive and car departments of a road having 140 engines and 11,000 cars, and making monthly shipments of scrap.

The scrap bin has a length of 258 ft. and a width of 40 ft. The floor is on a level with box car floors. The bins are 6 ft. high by 30 ft. long; the width of bins varies from 24 ft. to 6 ft., according to quantity of scrap to be stored in them. The bins and supporting structure were made from old car sills at a cost of $700 for material and labor. The classification of scrap and capacity of bins are as follows:

	Tons.		Tons.
1. No. 1 wrought iron...	250	16. Iron and steel punchings	70
2. No. 1 cast iron.....	300	17. Staybolts and limed iron.....	70
3. Tank sheets....	30	18. Brass skimmings	45
4. Light sheets	30	19. Brass ashes	30
5. Boiler steel....	45	20. Cast steel	90
6. Elliptic springs	50	21. Sacks, rope and hose.	20
7. Coil springs..	60	22. Mixed turnings.. ...	30
8. Flues	30	23. Cast-iron turnings...	50
9. Flue clippings	30	24. Wrought axle turnings....	30
10. Gas pipe....	20	25. Steel turnings	50
11. Journal boxes	60	26. Brass turnings and brass scrap....	40
12. Burned castings	60		
13. Malleable castings...	50		
14. Channel bars	30		
15. Soft steel	60		

When a carload of scrap accumulates at any point on the road, it is shipped unassorted to the scrap bins at main shop. At the car repair yards the scrap is picked up, unassorted, and placed on a car, which is run down the repair track for that purpose. When the car is loaded it is then taken to the scrap bins. The scrap is assorted as it is taken from the car and loaded in barrows and taken to the proper bins. It was found important that the scrap bins should be in charge of a man familiar with car construction, so that good second-hand material would be saved. In this plant an experienced car repairer has charge, as the large number of different castings used in car construction made it necessary to have some one in charge who was familiar with them.

It is truly a matter of astonishment what is found in scrap sent to the bins. New bolts, new washers, new castings, etc., are not infrequently sent to the bins with scrap material. Their presence there is due to the fact that car repairers order more material than is used on repairs of cars and this new material is gathered up with the scrap. It is sent back to the material bins for use. A large quantity of good second-hand material fit to be used again is removed from wrecked and from old cars. All good material of this nature is laid to one side and one man is engaged in wheeling this material to the casting pile or material bins, to be used again. The foreman of the blacksmith shop visits the scrap bins several times a day and advises the man in charge what forgings can be used again. By this double system of inspection all good serviceable material is saved, and the saving amounts to thousands of dollars in a year.

At one end of the scrap bin is a shed, 30 × 42 ft., where the shears operated by air pressure for cutting off bolts, rod, etc., are located, and near them the bench of the "brakebeam industry." All damaged metal brakebeams are carried here, and defective parts removed and good parts applied. Two damaged brakebeams will often make one good one without the use of new parts, but new parts are also provided and used when the second-hand parts run out of stock. After brakebeams are repaired they are taken to material platform in the car repair yard.

The great industry carried on in this shed, however, is that of making good bolts out of defective ones. If a bolt is not too badly rusted and has only a defective thread, it is cut off by the air shears, straightened by the bolt straightening machine, and then placed in bins (located near the shears) holding about a wheelbarrow load each. When needed they are taken to the bolt cutters and then to the material bins for future use. Old bolts have been utilized in this manner to the extent of 6½ tons per month. The saving in old bolts over the cost of new bolts amounts to $80 per month.

Car-coupler knuckles are inspected, and all that are bent and not otherwise defective are collected in lots of 100 and taken to blacksmith shop and thrown into a furnace. They are then straightened in a former, made in two parts, under a blow of steam hammer. The cost to straighten knuckles is 5 cts. each. If we assume that a knuckle is worth 47 cts. as scrap, and after it is straightened it is worth $1.66 as a good second-hand knuckle, deducting the cost of straightening, we have made a gain of $1.61 per knuckle, amounting to $96.60 per month.

Brass skimmings from the brass foundry were formerly sold to the highest bidder—each bidder taking a sample for examination before making a bid. In one instance after receiving a bid for this material it was dried and rattled in a flue rattler until the skimmings were cleaned. It was then sifted and the clean residue was melted and poured into castings. It was found that $125 was saved by cleaning and using the metal instead of selling the brass skimmings.

In my opinion, the important points in constructing and operating scrap bins are as follows:

1. Scrap-bin floors should be on a level with floors of box cars.

2. The work of assorting scrap should be under the supervision of a man who has had experience in car repairs, that good material may be picked out and set aside for future use.

3. Shears for cutting bolts, bolt straightening machine and a bench with vise should be installed.

4. The foreman of blacksmith shop should make several visits each day to scrap bins, inspect contents of same and have set aside such material as he knows can be used to advantage.

5. Good judgment must be used in regard to the working over of scrap materials, or it may cost more in the end than new material.

*Abstract of a paper prepared for the meeting of the Western Railway Club held at Chicago, Sept. 16.

†Superintendent of Motive Power and Machinery, Chicago & Eastern Illinois Ry., Danville, Ill.

THE STEEL FRAMEWORK OF THE FARMERS' BANK BUILDING, PITTSBURG, PA.

(With two-page plate.)

The business section of the city of Pittsburg has in recent years undergone rapid development. An expression of this advance may be found in the construction of modern office buildings; about half a dozen such structures of large proportions have been erected in the city within the past three years. Among these are the Empire Building, the Arrott Building, the Frick Building, and others, all of modern fireproof, steel-skeleton, tall-building construction, and up to 20 stories high.

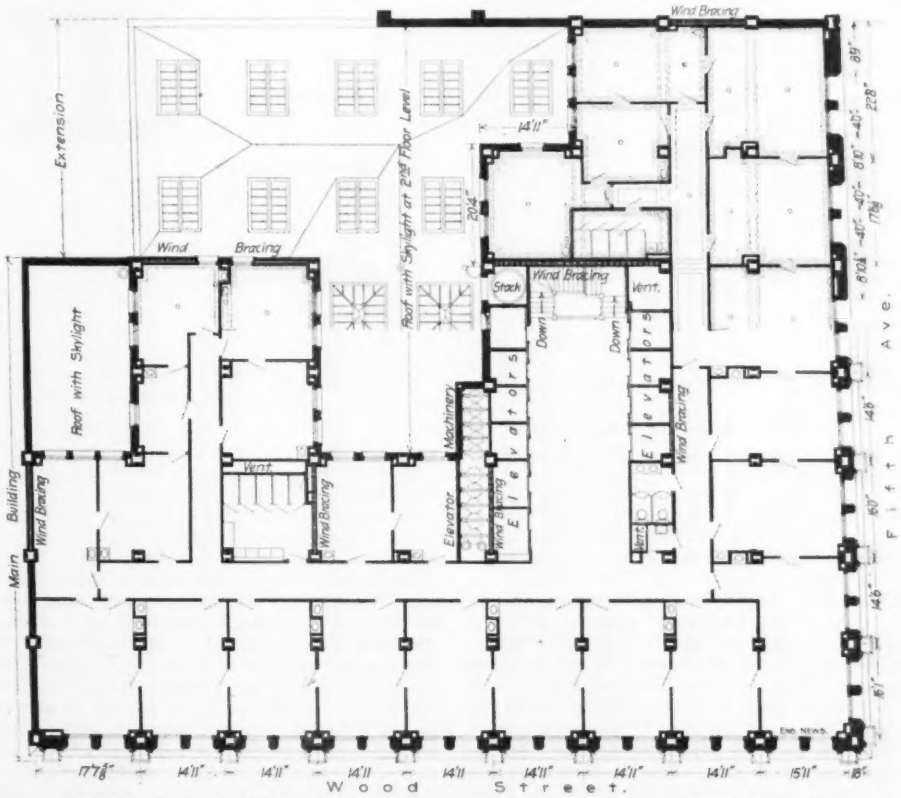


FIG. 1. TYPICAL FLOOR PLAN, FARMER'S BANK BUILDING, PITTSBURG, PA.

There is at present under construction another building of this class, which, when completed, will be the largest of Pittsburg's "skyscrapers," the Farmers' Bank Building, at the corner of Fifth Ave. and Wood St. It will stand on a plot of ground about 80 × 140 ft., and will occupy the whole area of the lot with the exception of two light-courts recessed into its rear longitudinal face. It will have 24 stories above the ground, besides an attic story below the roof, and a deep basement story with a partial mezzanine floor. The total height from first floor level to top of cornice will be about 327 ft. The depth below ground was limited mainly by the high groundwater level at times of flood in the nearby Monongahela and Allegheny rivers; even as it is the basement floor will be over 10 ft. below this level at the highest river stages.

The engineer's interest in a modern high building centers largely around the steel structural work. The following will, therefore, deal with this part of the structure, with the object of bringing out in detail the features of the design and construction that are connected with the special problems of the case. Sufficient general description will be given to make clear the disposition of the parts and to aid in comprehending the design as a whole.

The building is entirely of the steel-frame construction; it has steel columns, beams and windbracing, steel foundation grillages (upon which the columns foot by means of cast-iron bases), and bulkhead or sidewalk vault framing of braced steel beams on the two street frontages of the building. The walls above ground level are carried upon the framework throughout. The only portions of the building or its contents which are not carried by the main columns or the bulkhead uprights are: the basement retaining wall on the two sides of the building not fronting on the street; the smokestack which, though enclosed in a flue formed by partitions within the building, is self-supporting; the bank vault, which extends from basement floor to first story level, and is self-supporting; and the loads resting directly on the basement floor, which latter has no steel framing. The smokestack is supported upon a portion of one of the column foundations. The bank vault rests in part on the foundations of several adjacent columns, and in part upon separate foundations of its own. As further affecting the columns and foundations, it should be noted that party-wall arrangements have been made on the two sides of the building not fronting on the street, and that these columns and similarly their foundations, are set with centers on the lot line.

NUMERICAL DATA, ETC.—The site of the building lies in what appears to be an old bed of the Allegheny River. Borings carried to a depth of 80 ft. showed no rock. The material penetrated was a varying mixture of clay, sand and gravel, and boulders—typical river-bed material throughout that region. In the present instance it was thought best to estimate the safe pressure on this material very conservatively. Accordingly, the foundations were designed for a maximum pres-

sure of 6,000 lbs. per sq. ft. The other numerical data affecting the design of the framework were as follows:

The floors were figured for a total load of 150 lbs. per sq. ft., the roof for 125 lbs., and a gallery in the first story (not previously mentioned) for 100 lbs. Of the 150 lbs. for the main floors, about 90 lbs. per sq. ft. was taken to represent the dead load. In computing the column loads, the live load on the floors was reduced in accordance with the provisions of the New York Building Code, which provision was considered to be a fair allowance; it permits of reducing the live load on all tiers below the second from the top by amounts increasing successively by 5%, until a total reduction of 50% has been reached, the remaining floors to be taken as loaded with 50% of their live load. It will be understood, of course, that this provision relates only to the computation of the column loads, and applies only to buildings exceeding five stories in height.

Wind-pressure on the building was assumed at 30 lbs. per sq. ft. as a maximum. It was provided for by four bays of diagonal cross-bracing transverse to the building, each bay extending between two columns, and one bay of diagonal cross-bracing longitudinal to the building. These bays of bracing, or wind trusses, were considered as cantilevers fixed at the foundation and free at the top. It was found that the full load of 30 lbs. figured as going into this bracing would give a tension in the windward columns exceeding the dead load on these columns. To assume tension on any of the column footings was considered inadvisable, and the stresses in the wind-bracing were therefore figured backward from the dead load on the columns. This brought the safely permissible wind-pressure transverse to the building below the assumed 30 lbs., and the deficiency was made up by using knee-brackets at the connections of all interior columns to transverse floor girders. Similar systems of knee-bracing are used throughout the exterior walls, and the brackets here were made as large as the window openings would permit. Wherever knee-brackets are used, they are put only below the beams, as double (upper and lower) brackets would have involved considerably greater difficulty in erection.

Special loads on the framework include the exterior walls, two house tanks and two elevator tanks on the roof, elevator sheave supports, and expansion coils for the heating system, these latter being located on the 8th and 16th floors. The exterior walls are of marble in the first four stories, and of terra cotta and brick above this level. In the rear walls the wall girders consist generally of rolled beams connected directly to the columns (except in cases of cornices, etc.). In the front walls, plate girders were generally required in the spandrels, and it was considered advisable, particularly because of the variable levels here, to keep these entirely separate from the floor systems at their respective tiers; they were, therefore, supported on separate brackets projecting from the columns.

The material for the steel framework is medium steel, with an ultimate tensile strength of 60,000 to 68,000 lbs. per sq. in., and subject to the Manufacturers' standard specifications for this grade of material. The beams were figured for a unit stress of 16,000 lbs., riveted girders for 15,000 lbs. on net section, and columns in accordance with the Carnegie formula for medium steel columns. On the wind-bracing a stress of 20,000 lbs. per sq. in. was allowed. All material except the foundation steelwork (which is to be left unpainted) will have one shop coat of Nobrac paint or its equivalent, and one field coat; surfaces inaccessible after erection are to receive two shop coats.

It may be noted that all eccentric loads were allowed for in the design of the columns, and the stresses in the columns and beams due to the action of the knee-braces were figured by the methods used in calculating knee-braced portals. The field connections throughout the framework are riveted.

BEAM WORK.—The arrangement of the floor space of the building is shown by the typical floor plan,* Fig. 1. The location of the columns is also indicated in the plan; reference numbers are given on foundation plan, Fig. 10. The bays vary from about 14½ ft. to 17½ ft. in the transverse direction, and longitudinally from 14 ft. 11 ins. normal spacing to 17 ft. 7⅝ ins. The space covered by the elevator hall and elevators, etc., is a single bay of 29 ft. 10 ins. between columns, longitudinally to the building. The story heights vary from 25 ft. for the first story to a normal spacing of 11 ft. 11½ ins. between tops of beams above the fifth floor, with a number of stories having odd heights.

The arrangement of the beam framing in the different tiers could in the present building be made far more regular than is usually possible in office building construction. In the typical beam plan the girders are run transverse to the building. The floor beams themselves, spaced about 4½ to 5½ ft. on centers, are generally 9-in. × 21-lb. I-beams. At the columns their weight was arbitrarily increased, generally to 9-in. × 30-lb., so that they might with safety act as struts between the columns. The ¾-in. tie-rods are spaced about 5 ft. apart.

Fig. 2 will serve to illustrate the general arrangement of the beam framing; it represents the corner portion of the typical framing plan for

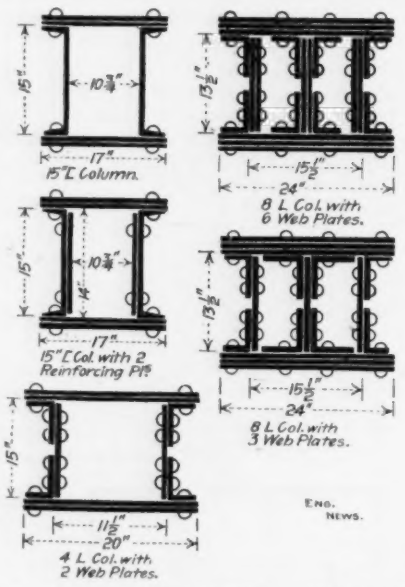


Fig. 3. Types and Sizes of Columns Used and System of Constant Dimensions, Farmer's Bank Building.

tiers 6, 8, 10, 12, 14, 16, 18 and 19. The wall girder construction will be made more clear farther on in connection with the spandrel sections. In addition to the wall girders a piece of special and heavy work was necessary in the first floor tier. The bank vault, which is entirely below the first floor, makes it impossible to continue column 39 to a foundation. In the first floor, therefore, a very heavy box girder extends from Col. 39B to Col. 49B, and carries Col. 39 upon its middle. The two supporting columns mentioned carry no other loads, and end at the girder; Col. 49B is directly beside Col. 49, in fact, forms part of it, and rests on the same base, while Col. 39B is under the end of the elevator hall, which space, as already mentioned, is covered by 24-in. beams spanning two regular bays. The box girder referred to has a section as follows:*

One box girder over bank vault.	3 web plates—43¼ ins. × ¾-in. 8 flange angles—6 × 6 ins. × ⅞-in. 4 flange plates—30 ins. × ¾-in. 2 flange plates—30 ins. × 11/16-in.

COLUMNS.—The columns are all of box section. Most of them are made up of two channels with cover-plates (latticing in the upper stories), and in some cases with a transverse web of plates and angles at the center. The heavier columns are made up of eight angles and three webs, with cover-plates. The heaviest column in the building is the basement section of Col. 3, with a total maximum load of about 1,500 tons; its section is made up of:

One basement column—Column 3.	6 web plates—13 ins. × ⅜-in. 8 angles—6 × 4 ins. × ⅝-in. 2 cover plates—24 ins. × ⅝-in. 4 cover plates—24 ins. × ¾-in.

with a total gross section of 233 sq. ins. The smallest column section used consists of two 9-in. channels latticed.

To expedite detailing, the columns were kept of constant dimensions for each of the different styles and sizes. Thus, all 15-in. channel columns with reinforcing web-plates are made to certain standard dimensions, all columns of four angles and plates to certain other standard dimensions, etc., all as shown in Fig. 3. The sections not shown in Fig. 3 are made to standard dimensions as given in the Carnegie handbook.

It will be noted that most of the column sections shown are rectangular, with one dimension longer than the other; such columns, in the interior are set with their longer dimension across the building, to give increased stiffness in this direction. Two-story lengths were generally used, and as is often done at the present time, these lengths were not staggered, but were spliced at the same tiers. The basement and first story columns are made in single lengths, partly to facilitate delivery for this part of the material and partly to make these heavy sections easier to handle. The splices, further, are not made at uniform distances above the floor levels, but at varying distances, to suit the number of rivets required. A typical length of column is shown in Fig. 4, which represents a second story interior column. The brackets under the beams, to which attention has already been called, will be seen in the drawing. Another detail, showing the bracket on the column, and showing also a column splice and the ordinary shelf-angle beam-connection, is shown in Fig. 7, at C.

WIND-BRACING.—The wind-pressure to be provided for has already been noted—30 lbs. per sq. ft. of exposed surface. There is a full system of crossed diagonals, from foundation to roof, in each of the following four bays: Col. 15—Col. 24; Col. 18—Col. 27; Col. 20—Col. 29; Col. 12—Col. 21. These are all transverse to the building. In the longitudinal direction there is a similar system in the bay Col. 3—Col. 4. In the bay Col. 1—Col. 2 full diagonals could not be used, and a system of knee-struts is here employed. As was mentioned above, these systems of bracing are not sufficient to provide for 30 lbs. wind-pressure transverse to the building, and knee-brackets were therefore used at the connection of all transverse floor girders to columns. The whole Fifth Ave. front and the rear wall from Col. 15 to Col. 43 are also provided with such knees between the columns and the wall girders, and similarly the Wood St. front; in the latter, however, the knees are omitted in both end bays, as it was considered inadvisable to make the corner columns (43 and 52) do duty for wind-bracing in both directions.

Fig. 5 shows in diagram the lower and upper portions of the various bays of bracing. The bays grouped under B have stresses nearly equal throughout, and show only minor differences in the sections used. A detail of two of the bays of bracing is shown in Fig. 6, at B and C, respectively. In the same figure is shown, at A, a detail of the connection of the wind-bracing to the columns.

The knee-brackets which form the auxiliary bracing were limited in size by the openings in the walls, etc. Fig. 7 shows at A the general scheme of arrangement of the brackets in the front walls, the portion shown being the lower part of the Fifth Ave. front. At B in the same figure is given a typical detail of these brackets. The brackets on the interior columns are illustrated in typical detail by C, Fig. 7.

SPANDREL SECTIONS, ETC.—The wall girder work differed in levels, loads, etc., at nearly every point. In most cases plate or box-girders were required, connected to the columns, independently of the floor framing, by the knee-brackets just described. A number of spandrel sections are grouped in Fig. 8, and these fairly represent the different arrangements used. At cornices, and where similar projections occurred, special brackets were required. The support of the main cornice, at the 22d story level, required a longitudinal beam carried some distance out from the face of the wall by brackets attached to the columns. The rear wall spandrels are generally quite simple;

*See additional note at close of this article in reference to the part marked "Extension" in Fig. 1.

*It may be of interest to state that the shipping weight of this girder was 27,200 lbs.; the column noted just following is of about the same weight.

such a section is shown at F, in Fig. 8. A further detail connected with the wall girder work is shown at G, Fig. 8; a number of caryatids occur at the third floor level, and they are supported by brackets, as shown on the webs of the heavy box-girders which form the wall girders at this level.

The construction of the sidewalk vault has already been mentioned; a typical cross-section through this space is given in Fig. 9. The bulkhead construction comprises 15-in. I-beam uprights, framed at top and bottom into longitudinal channels lying flat. At the level of the basement mezzanine a 24-in. I-beam with horizontal web runs along between the uprights and carries their pressures into the floor beams of the mezzanine to the columns. The bulkhead uprights frame into this beam; below it they are of 80-lb. section, above of 60-lb. section. The earth pressure on this bulkhead was figured on the assumption of the material weighing 100 lbs. per cu. ft., and having an angle of repose of 45°. The uprights are spaced about 5 ft. on centers; they are tied together at intervals by ¾-in. tie-rods. The bulkhead wall will consist of brick arches sprung between the uprights, leveled up inside and outside with concrete. As the groundwater level at times of flood is considerably above the basement floor level, the wall is provided with damp-proofing just outside the beams. The same damp-proofing is carried over the whole basement floor, and encases the lower portions of the columns and their bases, as will appear below in the description of the foundations.

FOUNDATIONS.—The subsoil conditions at the site have been described previously. The material as disclosed by the borings is a very good one, and might have been trusted with a much higher loading than was adopted; on the other hand, various reasons made it seem advisable to keep the load on the soil down to a low figure: thus, poorer material might exist in layers or streaks farther down, future excavations might be made nearby which would go below these foundations, the narrowness and great height of the building were to be taken into account, etc. It was therefore concluded to use a safe load of 6,000 lbs. per sq. ft. in the calculations, wind pressures as well as the weight of the foundations themselves being neglected. The columns gave some heavy loads to be provided for, which in many cases rendered it quite difficult to get sufficient bearing area. Where wind-bracing occurred, it was judged specially important to prevent, as far as possible, unequal settlement of the connected columns, as this might throw a large vertical shear upon the diagonals of the bracing. In these bays, therefore, the foundations were made continuous, either in the lower tier of the grillage beams, or in the foundation layer of concrete. In general the different column foundations were made independent, except as noted in the braced bays, or where large column loads made it necessary to combine two or more foundations to get the required area of bearing.

A plan of the foundations is shown in Fig. 10, where the principal dimensions and the make-up of each foundation are noted. It will be seen that generally two tiers of grillage beams are used, resting on a block of concrete 2 ft. thick and projecting 6 ins. beyond the beams all around. In some cases three tiers of beams were necessary, for instance in the case of Cols. 10 and 11, Cols. 3 and 4, etc. In the case of Cols. 10, 11, 20 and 29, the lower tier of grillage beams is continuous, below all four columns, but at Cols. 10 and 11 it was necessary, in order to get greater bearing area, to add extensions to this lower tier at both sides.

Sections through two sets of footings are shown at A and B, Fig. 10; the 2-ft. layer of concrete will be seen extending in both the cases shown under four consecutive columns. Upon these rest the grillage beams, which are indicated in the sections A and B without their surrounding protection, which will be described below. Under Cols. 3 and 4 the lower tier of beams is continuous, which effectively unites the two footings into one; this is done not only because wind-bracing occurs in this bay, but also because of the great loads on each of the two columns, which, together with their location on the boundary of the lot made it necessary to adopt this method to get the required bearing area.

The detail construction of the column foundations and basement floor is interesting. As the groundwater level at flood times is considerably above the basement floor level, thorough waterproofing of the floor and thorough protection of the column footings were essential. The arrangement adopted is shown in the detail, E, Fig. 10. The grillage beams are completely encased in concrete, and over them is built a brick well large enough to receive the column base and afford a working space for connecting the column to its base casting. The column is then placed and bolted, being surrounded by waterproofing of felt and asphalt as indicated by the heavy black line. The waterproofing extends over the whole basement floor, bedded in the concrete, and connects with the waterproofing of the sidewalk vault, as shown. At the column one layer of it is lapped up along the column for 2 or 3 ft., and another layer turns down and surrounds the cast base. The grillage is thus protected by its concrete, and the column is protected besides by its waterproofing, giving double assurance against corrosion.

In executing this foundation work, one end of the building is first excavated down to the bottom line of the foundation concrete; then this concrete is laid, the grillages placed and surrounded with concrete and the cast bases bolted in place. The brick wells around the columns are then carried up to the floor line. Work is now begun on the remaining footings, and the excavated earth is used for backfilling around the finished wells to the required level. This procedure saves a large amount of earth removing and rehauling for backfilling, while leaving the work in such shape that all columns can be set and the erection of the steel work begun after the foundation work is completed. Care is taken to excavate only down to the proper level for placing the foundation concrete, so that all of the footings rest on undisturbed ground. The concrete of the basement floor is placed after the lower sections of the columns are in place, the brick wells enabling the waterproofing and concreting around the columns to be done conveniently and thoroughly.

By reference to the plan of the foundations, it may be seen that Col. 3 is set 2½ ins. off the center line of its footing. This is done because of the fact that the stack, already spoken of as being self-supporting, foots upon the same foundation as and directly adjacent to Col. 3. This foundation is therefore set in such a way that the resultant load from stack and column comes over its center line.

Another special bit of foundation work, which, however, could not be as closely calculated as the one just mentioned, occurs between Cols. 39B and 49. In this space will be seen a broken line, representing the outer line of the bank vault which extends from the basement floor to the first floor. The vault is constructed of 5-in. armorplate and concrete, and weighs about 300 tons. It was desired to make its foundations entirely distinct from the column footings, but this could not be completely realized. Two brick walls, resting on spread concrete footings, run from the footing of Col. 49 to that of Col. 39B; they carry the central portion of the vault. The remainder of the vault is supported on the footings of the adjacent columns 29, 38, 48, 39B and 49; the footings are in each case spread as much as possible beyond what was required for the column, so as to distribute with some uniformity the extra loading from the vault. While the case did not permit of accurate

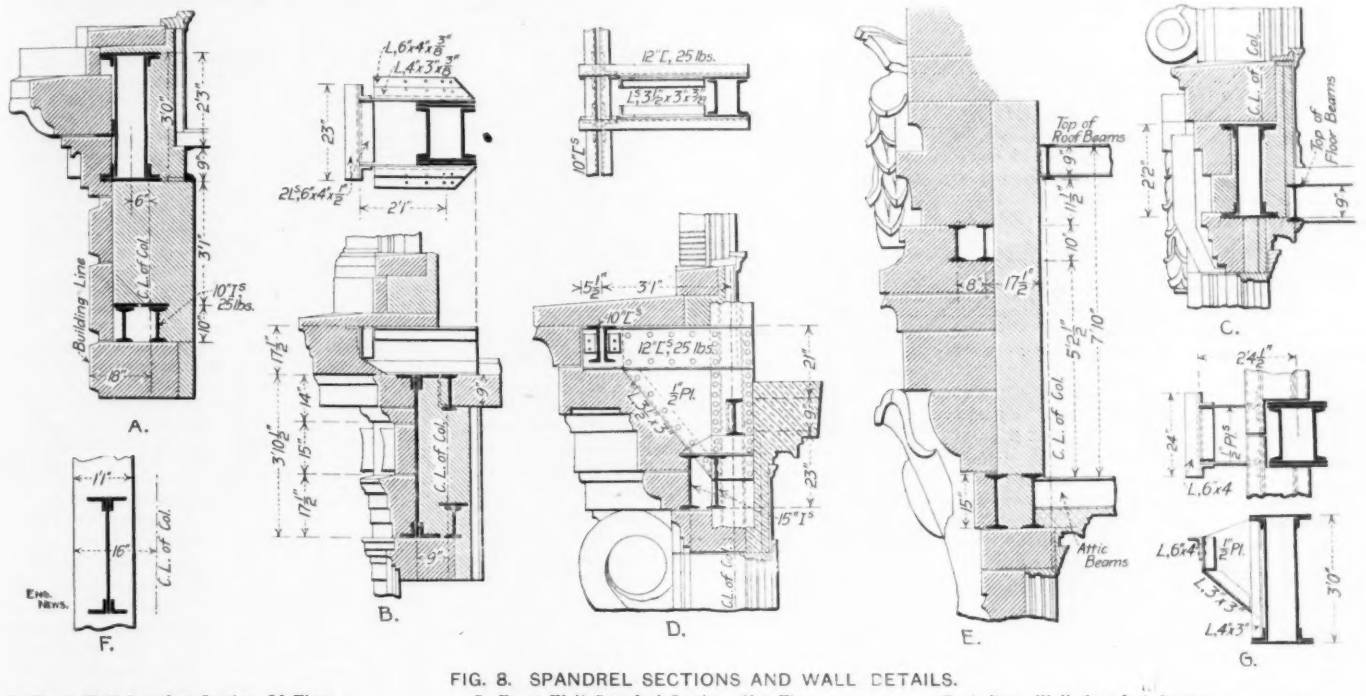


FIG. 8. SPANDREL SECTIONS AND WALL DETAILS.

A—Front Wall Spandrel Section, 3d Floor.
B—Front Wall Spandrel Section, 4th Floor.
C—Front Wall Spandrel Section, 21st Floor.
D—Front Wall Spandrel Section, 22d Floor.
E—Front Wall Spandrel Section, Attic Floor and Roof.
F—A Rear Wall Spandrel Section.
G—Brackets for Caryatids, Front Wall, 3d Floor.

figuring as to the distribution of the pressures, there is more than enough additional bearing area provided to safely take the load of the vault. A separate plan and a section of this bank vault foundation is shown at C and D, Fig. 10. The plan C indicates the four brick walls which directly carry the vault. The spaces between them are filled with dry sand, rammed in. The plan also shows the brick wells surrounding the lower parts of the columns.

The design of the foundations is the work of Mr. Corydon T. Purdy, M. Am. Soc. C. E., Chief Engineer of the Geo. A. Fuller Co., building contractors, of New York, Chicago and other cities. This company is erecting the building complete.

The architects for the building are Messrs. Alden & Harlow, of Pittsburg. The steel work, with the exception of the foundations, was given in charge of the Carnegie Steel Co., Mr. John C. Neale, Structural Engineer. The entire design of this steel work was prepared by Mr. R. B. Woodworth, Engineer with that company. We are indebted to Mr. Woodworth for blue prints and information used in the preparation of this article.

EXTENSION.—When work on the construction of the building had already been begun, additional real estate adjacent on the Fifth Ave. side was acquired; the design for the extension of the building over this lot was at once taken in hand, and this portion will probably be constructed at the same time as the other.

The plan of this extension is shown on the typical floor-plan, Fig. 1. The rear portion is only one story high, with a skylight at the second floor level; the front part, however, will be carried up to the full height of 24 stories like the main building. A large court will thus be left to the rear, joining with the courts in the main portion, as noted previously.

The design of the extension is on exactly the same lines as that of the main portion, and will therefore require only a few words of additional explanation. The Fifth Ave. facade will continue uniform across the extension, and the spandrel work will therefore be the same. The rear-wall spandrel work also needs no further mention. The arrangement of the columns is shown on the plan Fig. 1; the beamwork will be arranged as in the main portion, having 9-in. I floor beams parallel to the Wood St. side, carried by suitable floor girders. The system of knee-brackets between columns and girders is maintained throughout this extension.

There will be one bay of wind bracing, between Col. 61 and Col. 62; this bracing is almost identical with that in the bay Col. 15-Col. 24. The sidewalk vault with its bulkhead framing will also continue uniform over the Fifth Ave. front of the extension. The foundation work will be designed on the lines of that provided for the main building as described in full above. The foundations on the division line between the main and addition portions had already been planned so as to be suited for either a party wall or an extension to the building.

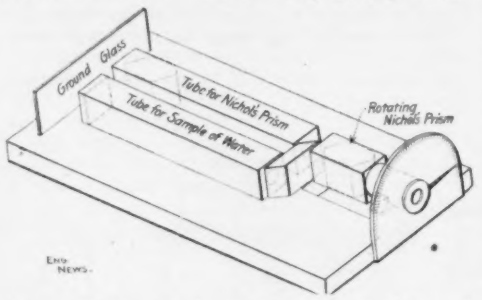
A NEW TURBIDIMETER.

A new instrument for determining the turbidity of water was described before the New England Water-Works Association, last week, in a paper sent from England by Mr. Chas. Anthony, Jr., C. E., of Glenview, Hereford. The paper opened with an outline of the various methods heretofore used for determining turbidity. The best of these, the author stated, is Hazen's platinum wire method, which

> is, indeed, the acme of simplicity, but labors under two serious drawbacks: That its scale—the reciprocal of the depth in inches at which the wire becomes invisible—is entirely arbitrary, and that observations made under different conditions of illumination are not strictly comparable. It may be dismissed, therefore, as not a strictly accurate or scientific method, though useful in practice in certain cases on the score of simplicity.

After dismissing likewise all the other methods heretofore in use as deficient for one reason or another, the author stated the desirable qualities of a turbidimeter and described the new device as follows:

> Some simple photometric method of measuring the absolute amount of light absorbed by a given thickness of water appears to the writer the most rational and convenient method of estimating the degree of turbidity of a water, and with this object he has designed the form of instrument illustrated in the accompanying figure.
>
> It consists, as will be seen, of a couple of parallel tubes of standard length, say 50 cm., one of which, closed at the ends by plates of glass, contains the water to be examined. Light transmitted preferably through ground glass reaches the eye, in part through this water and in part directly after passing through a Nicol's polarizing prism. These two sources of light are observed through an eyepiece containing another Nicol prism. The field of view is thus seen neatly dichotomized. By rotating the eyepiece, the illumination of that half of the field which received its light directly, seeing that it has already passed through a Nicol prism, can be varied until it matches the half receiving light through the standard thickness of water under examination. And though the inevitable difference in tint introduces some error due to personal equation in estimating equal obscuration, the extremely convenient manner in which the lights from the two sources are seen in absolute juxtaposition in the same field of view, allows of more accurate comparison than by any of the methods hitherto suggested. Further, seeing that the obscuration varies, according to a well-understood relation, with the angle through which the eyepiece is rotated, the instrument can be made to indicate, on a properly graduated



A New Device for Determining the Turbidity of Water.

> disk, the degree of obscuration, that is, turbidity, to a rational scale, in which 1 represents perfect transparency and 0 total obscuration.
>
> In conclusion, it may be pointed out that the instrument is most easy to handle, gives accurate results to a rational scale, and is independent of the source of light. For these reasons the writer believes it well adapted to fill the long-felt want of a ready and standard means of making turbidity observations.

In opening the discussion on the paper, Mr. Allen Hazen, M. Am. Soc. C. E., said the device was entirely new to him, and looked interesting. He would like to see it tested and compared with others. The objections to the platinum wire method had long been recognized. When it was adopted at Lawrence the scale had to be arbitrary. Since then data has accumulated, as he hoped to tell in his paper that afternoon.* The inaccuracies due to variations in the intensity of light are less than might be supposed.

Mr. Chas. W. Sherman, Assoc. M. Am. Soc. C. E., thought that the instrument was limited on account of having an angle of only 90° to read through. The apparatus is similar to one described before the association by Dr. Frederick Hollis.

*See report of the convention of the New England Water-Works Association, elsewhere in this issue, from which it appears that the arbitrary scale of the platinum wire standard has now been changed to a natural one.

ANNUAL CONVENTION OF THE ROADMASTERS' AND MAINTENANCE-OF-WAY ASSOCIATION.

The 20th annual convention was held at Milwaukee, Wis., Sept. 9 to 11, the headquarters and meeting rooms being at the Plankinton House. There was a good attendance, and the convention was very successful, although the entertainment arrangements interfered somewhat with the progress of business, especially in encouraging a tendency to save time by cutting off discussions.

The first session was held in the morning of Sept. 9, when an address of welcome in behalf of the city was delivered by a representative of the mayor. This was followed by the annual address, delivered by the President, Mr. I. O. Walker (N., C. & St. L. Ry), who discussed the relations between the track and the rolling stock. He referred to the enormous weights of modern engines, cars and trains which are being introduced not only on railways having good and substantial track, but also upon roads having light rails, poor ballast and other features of inferiority. Under these latter conditions it is practically impossible to maintain the track in safe and smooth condition.

At this session Mr. Burnett, the first President of the Association (which was founded in 1883), was elected an Honorary Member. It was also announced that a button badge had been adopted, and at the close of the convention these badges were distributed to the members. The first technical matter to be taken up was the report of a committee on the education of section foremen, and an abstract of this is given below:

THE BEST METHOD OF EDUCATING YOUNG MEN AS SECTION FOREMEN.

The problem of selecting young men with the view of training them for section foremen is a much more difficult one now than it was a few years ago. The modern complicated switch and signal appliances coming under the care of trackmen, and the high standard at which the railway track of to-day must be maintained, make it necessary to employ better educated men, who are capable of higher development.

The chief difficulties in securing such men are, first, that their wages are small, as a rule less in proportion than in any other department of railway service; second, there is not sufficient encouragement for the young man to perfect himself in track work, as the man who has worked faithfully for years fitting himself for the position of foreman, is required to labor beside the newly hired and inexperienced man, both receiving the same compensation. For these reasons we have generally been compelled to employ the more ignorant class of laborers, the better educated men seeking more lucrative employment.

So few section foremen of this day are influenced to perfect themselves in construction and maintenance by the hope that some day they may be extra gang foremen or roadmasters, that one finds but few men looking for such a position who are educated beyond the requirement of a day laborer. How to educate men for this position, then, first comes to the roadmaster in the form of the proposition of how to get the men to take the position who are capable of being educated to hold it.

Under the present circumstances, requirements and salary considered, we find it the best plan to pick up young men from section gangs with the apparent mental qualifications, and at once begin to work them in charge of crews, place them in charge of a section just as soon as we find they can handle men and are trustworthy, training them by visiting them as often as possible, instructing and telling them what to do under certain circumstances and conditions. If you can put a young man as a sub-foreman on construction work for a few months it would be found very beneficial to him as an educator. Much education can be given old as well as young foremen by having meetings of these men on each division, having them discuss matters together, the roadmaster being with them and talking matters over with them. L. Bradley, Chairman; S. R. Rice, A. L. Mead, E. P. Hawkins.

This report gave rise to a lengthy discussion, to which we have referred in our editorial columns. The gist of the discussion was that owing to the very low rate of wages paid it is practically impossible to get and keep in the track forces a class of men competent for the skilled and responsible work involved in the maintenance of modern railway track. There has been no such increase of wages as has taken place in most other lines of labor, and there is no scale of wages by which the experience or skill of individual men may be recognized. Mr. Buhler (L. S. & M. S. Ry.) favored higher pay for certain men in the gang, but Mr. Cornell (C. & N. W. Ry.) thought that in the West where there is so much floating labor it would be impracticable to have a scale of wages or any difference in wages, as the men receiving the lower pay would at once demand the same rate as their fellows, and quit if they did not get it. Several members expressed similar opinions, but others thought the plan might be practicable in some States, and also advocated the plan of having a sub-foreman, with a slight increase in pay. Mr. Coates (C. G. W. Ry.) approved of the committee's suggestion as to bringing foremen together to talk matters over among themselves and with their roadmaster. Mr. Doyle (P. M. Ry.) spoke strongly in favor of an apprentice gang of foremen. This would be an extra gang composed of intelligent young men selected from the section gangs, given an increase of pay, and working under an experienced foreman, who would instruct them in switch and interlocking work, gravel train work, the keeping of accounts, etc. These men would soon be competent to take positions as section foremen. Mr. C. E. Jones (C., B. & Q. Ry.) thought the most serious difficulty lay in getting men, as good men can get much better pay in other branches of the service.

The discussion on this subject occupied the remainder of the morning session and a part of the afternoon. It was followed by a short address from Mr. John P. Brown, Secretary of the Inter-

national Society of Arboriculture, on the subject of

TREE CULTURE.

This address dealt particularly with the advantages of the catalpa-speciosa as a railway timber, and its special merits as a tie timber. It has a rapid growth, furnishes a larger amount of timber per acre than many others, and is very durable without preservative treatment. Taking up individual cases where the catalpa has been spoken of as a failure, he explained the reasons, which are usually neglect or improper treatment, or the planting of an inferior species of catalpa. He described the new plantations on the Illinois Central R. R. and Boston & Maine R. R., as recently noted in our columns; and stated that among other railways taking up this matter are the Denver & Rio Grande R. R., and the Boston & Albany R. R.

TRACK JACKS.

The report of the committee on this subject was then presented, and an abstract is given below:

While we find there is still room for improvement on track jacks, we find that they are the best adapted tools for raising tracks. The track jacks that give the best results are the ones that do the work the quickest, raise the track safely and accurately, and will release quickly. Track jacks are subjected to different kinds of track work. In yards and around switches and frogs, the work is perhaps heavier than elsewhere; consequently the strongest and most reliable jack, even though not as quick as others, would be satisfactory. There would not be so many men in yards waiting for track to be raised as there would be out on the road, where usually a large force of men are employed. Out on the road the best and quickest jacks are required in order to keep the men at work, and also to prepare the track with despatch for traffic.

For general track repairs, a light, handy jack, that one man can handle, would be satisfactory, and most suitable for the surfacing of track. It should be so designed as to be carried conveniently by one man in order to get on with the required surfacing of track, and should be so constructed that the track could be raised the required height. For general track repairs we would recommend a ratchet jack not exceeding 65 lbs. in weight; for new ballasting a friction jack not exceeding 95 lbs. in weight. T. Hickey, D. E. Crowley, A. M. Hawkins, T. J. McClosky.

The committee's report mentioned certain makes of jacks, but it was thought wiser to strike out the names, since there is no one make of jack that is superior to all others in every respect and for all kinds of work. Mr. Allen (C., B. & Q. Ry.) remarked that while individual roadmasters have their preferences, his road has thought it best to select and adopt a certain type as its standard rather than to purchase jacks of all kinds. The report also recommended the ratchet type of jack for general work and the friction type for new ballasting; but Mr. Coates (C. G. W. Ry.) and Mr. I. O. Walker (N., C. & St. L. Ry.), among others, favored exactly the reverse practice.

A paper by Mr. J. C. Rockhold (A., T. & S. F. Ry.) was then read, as follows:

SHOULD RAILS BE CURVED BEFORE LAYING?

If it is essential that rails on tangents be perfectly straight, then it is equally necessary that rails for curves be accurately and uniformly bent to fit the particular curve for which they are intended. This rule applies with equal force to all curves of 2° and over.

But someone may remark: "Curving destroys the elasticity of the rail, and works an irreparable injury; therefore rails should not be curved." Originally the curving was accomplished by blocking up each end of the rail 18 or 20 ins. from the ground, while eight or ten men stood on it to prevent recoil from the blow, one or two others would strike the base and ball vigorously with a 12-lb. sledge from end to end, by which process the rail was not only curved, but all the life was hammered out of it as well. If when turning it up "workways" it was found to have been curved too much, it was again turned over, with the curved side up, and the previous performance repeated. This method was ultimately displaced by the use of the "curving hook," which in time gave way to the various forms of "jim-crow" rail benders, and which in turn were crowded out of the market by the "roller" bender; the latter being standard on most of the leading lines to-day. This bender is either operated by hand or steam power.

However, it is a serious question with all thoughtful men interested in maintenance-of-way matters whether any method of cold bending is the logical one. When we consider the resources and facilities of the modern steel concerns, we see no reason why rails cannot be curved at the mills while hot, as easily as they can be turned out straight.

The proposition for hot-bending at the mills was not regarded with any favor, on account of the extra expense, the trouble in transportation, and especially in getting the proper number of rails bent for each degree of curve required, and the difficulty in distributing them to the points where they are to be used. It was also suggested that if the curving done at the mill was of no better a character than the "gag" method now still frequently used for straightening, at the mills, there would be no improvement over cold bending by the trackmen. For proper hot curving a special plant would be required at the mills. It was the practically unanimous opinion that rails should be curved before being laid, but that present machines and methods could be considerably improved. One difficulty is in getting the curve true and uniform throughout the length of the rail, and Mr. Allen (C., B. & Q. Ry.) spoke of the difficulty of getting the curve continued to the ends of the rails, where the splice bars fit. The ends are frequently almost straight and cause a series of kinks in the curve.

This discussion was followed by another committee report:

FENCES AND CATTLEGUARDS.

For a good, substantial and hog tight fence in a rough or rolling country, we recommend a fence built of five barbed wires, one plank at bottom and one at top, the two bottom wires being hog wires. The posts to be of cedar, 7½ ft. long, spaced 8 ft. apart. This fence should only be maintained in a rough or hilly country where woven fence would have a tendency to pull posts up on low spots. On level country, we would recommend a 26-in. or 28-in. woven wire (square mesh) at bottom, with three barbed wires on top if you want to maintain a hog or sheep-tight fence. Posts to be same as above. For common fence, where it is not necessary to make it hog tight, would recommend fence made of five barbed wires, using 7-ft. posts, spaced 8 ft. apart; posts to be made of best available timber with stay wires every 20 rods.

Your committee has had a good deal of experience with several different forms of surface cattleguards, and have never seen or used a surface cattleguard which gave entire satisfaction without making a pit under the guard by using wider timber than the regular cross ties and cleaning the ballast to the bottom of the ties. This should not be done, at it allows water to soften the roadbed and ties to shift out of their place, which generally causes low spots in track.

A surface cattleguard should be conconstructed in such a manner that live stock in stepping on it would not have good footing. All surface cattleguards should be at least 12 ft. long.

Wing fences should be maintained of same material that cattleguard panel is made of; that is, if your cattleguard panel is made of barbed wire, wing fence should be wire. However, the committee recommends that wooden wing panels be maintained and that one panel of wing fence be made of boards adjoining the cattleguard panel; balance of wing fence should be constructed the same as balance of right-of-way fence. We do not think it advisable to use a full board-line fence from cattgleguard to right-of-way line at public highway crossings, as such fence obstructs the view of the engineman so that he cannot see stock which might be standing behind the fence until they come upon the track.

Our idea for one panel of board fence adjoining cattleguard is that it can be whitewashed and then makes a very neat and attractive- looking crossing. Many people would drive into a crossing many times and never know they were approaching a railroad crossing if it were not for the fact that line fences are whitewashed and very readily seen and noticed. Therefore, we recommend that all line fences at public highway crossings should be kept whitewashed. W. Shea, Chairman; P. Rockwell, D. Foley, R. H. Penticost.

The discussion developed the fact that very few of the surface guards now in use will turn cattle effectually. The same subject was taken up for discussion the next day, when two gentlemen were present representing a commission appointed by the Canadian government to enquire into the best form of railway cattleguard. Several members then expressed the opinion that the pit cattleguard is the only one that will effectually turn stock, but at the same time none approved of this form of guard, as it is a source of danger to derailed trains and to flagmen, usually makes a bad place in the track, and is also liable to trap cattle which make the attempt to cross. On the whole, it is safer to run the risk of killing cattle on the track than wrecking a train. Both the Chicago, Burlington & Quincy Ry. and the Chicago & Northwestern Ry. are now taking out all their pit cattleguards as the result of experience with getin cattle caught in them. On the Pere Marquette R. R. a cheap and satisfactory cattleguard is made by laying six ties parallel with the rails (one under each rail, two between, and two outside), and then laying the ordinary cross-ties upon these. Mr. McEniry (C., R. I. & P. Ry.) remarked that in Iowa the law requires the use of a "good and sufficient" cattleguard, and instanced a case where a jury of farmers found in favor of a railway company in a suit for damages for killing cattle. Their verdict was based upon the evidence that the company had complied with the law, and could not, therefore, be held liable. In regard to fences, Mr. Jones (C., B. & Q. Ry.) described a method of strengthening fences composed of horizontal wires by means of a system of vertical stays.

The last paper of the afternoon was by Mr. J. M. Meade, Resident Engineer of the Atchison, Topeka & Santa Fe Ry., and an abstract of this is given below:

TRACK DRAINAGE.

The stability of the track and roadbed depends largely upon this matter, but on the majority of roads it does not receive the attention it requires, and its importance should be more strongly advocated by those in charge of track work. Economy in track maintenance begins right here. The saving to rails and ties is largely augmented by good drainage to say nothing about the wrecks that are avoided. A severe rain storm will often spoil weeks and months of hard and expensive track work by the section men by neglect in this direction. Keep your ditches clean and educate your foremen to the importance of this matter and let them understand the value of having every ditch big enough to carry off all the water that will ever come into it, and sufficiently deep to keep the moisture away from the ties and ballast.

Frequently cuts will break away and slide in from the hillside water. This can often be permanently stopped by surface ditching placed some distance back from the top edge of the cut as circumstances warrant. In cases where this will not give relief the trouble can often be overcome by cutting vertical trenches on the slope of the cut from top to bottom placed about 15 or 20 ft. apart, mounding up the excavated dirt between the ditches.

Banks should be drained by proper sloping; rough track is often found on embankments caused by ties being buried in mud; this could all be avoided if they had free drainage on a slope of at least ½ in. in 12 ins.

We often meet with material in cuts of a wet and boggy nature, where stone ballast will not keep the track smooth. Bad cases of this kind are often cured by increasing the grade in the cuts and introducing porous tiling in the ditches and putting a good lift of cinders on top of the stone ballast. The cinders being porous do not retain the moisture and do not heave like other ballast from the action of the frost.

There was not much discussion upon this report, and it related principally to tile drainage, not only for the track, but also at highway crossings. Porous tile is commonly used, but one member spoke of using salt-glazed tile, as the water enters mainly at the joints.

At the morning session on Sept. 10, the first subject taken up was that of

GASOLINE INSPECTION CARS.

Representatives of different makes of these cars had been invited to be present, and a Sheffield car exhibited in the meeting room was described in detail, especially in regard to the construction, operation, repair and maintenance of the engine. This was listened to with the closest attention. The Sheffield Car Co. began its experiments in this direction about seven years ago, and stationary engine practice was at first largely followed, but it was very soon found that the special conditions would necessitate material changes, particularly in reducing the weight, and devising successful forms of igniters and gas mixers or carburettors. Experiments and experiences have resulted in the production of a satisfactory engine which will propel a car at a speed of 20 to 30 miles an hour on good straight track that is free from frogs and switches. An 8-cell dry battery is used for the igniter. Ordinary stove gasoline of 70° test is used for the engine, or a special mixture of about 76°. The object in introducing these cars was to save the hard labor involved in propelling large cars by hand, and also to avoid the necessity of taking section men from their work to run an inspection car.

The next report presented was that of the Committee on Ties and Tie-Plates, an abstract of which, with notes of the discussion, is given in another column.

NEW AND IMPROVED APPLIANCES FOR USE IN MAINTENANCE OF WAY.

This was the last report, and being presented at the last session, received but little attention, and was promptly accepted as read, although it should have brought out considerable discussion. The President remarked, however, that the Executive Committee had intended the Committee on Appliances to investigate and report upon new devices, instead of which the report consisted mainly of recommendations. An abstract of this report is given in another column.

NEW OFFICERS AND PLACE OF MEETING.

The election of officers resulted as follows: President, John Doyle, Superintendent of Tracks, Pere Marquette Ry.; First Vice-President, F. R. Coates, Chief Engineer, Chicago Great Western Ry.; Second Vice-President, J. A. Kerwin, Missouri, Kansas & Texas Ry.; Members of Executive Committee, C. E. Jones (new member) and J. L. Single (taking Mr. Doyle's place); Secretary and Treasurer, Charles McEniry, Roadmaster, Chicago, Rock Island & Pacific Ry., Cedar Rapids, Ia. The next meeting will be held at Kansas City, Mo., in 1903, and is to be a four-day meeting.

ENTERTAINMENTS AND EXHIBITS.

The entertainments included a theater party, a visit to the State Fair (one of the attractions at which was a collision between two old locomotives), a trolley ride to points of interest, and a reception at the hotel. There were also drives and a tally-ho ride for the ladies. The Road & Track Supply Association had arranged an extensive exhibit of tools, appliances, etc., some notes of which are given in our supplement.

A CONVENIENT MACHINE FOR LOADING TIES.

The loading of ties on cars for distribution is a work which causes considerable trouble to the officers in charge, as it is difficult to get men who are able to perform it continuously, and still more difficult to keep the men, as the work is so hard that they prefer to quit it. This is more particularly the case with ties treated by a preservative process, which sometimes weigh as much as 200 to 250 lbs. each. These troubles are most serious in sections where labor is scarce and expensive, and in view of these troubles a labor-saving device in the form of a tie-loading machine has been invented by Mr. F. J. Angier, Superintendent of the tie-preserving works of the Burlington & Missouri River R. R., at Sheridan, Wyo.

It consists of a runway, Y-shaped in plan, suspended from the car roof. The straight leg extends over the loading platform and spans the track on which the trucks are run. The runway may be a bar or plate ¼ × 3 ins., or a light 4-in. I-beam for the straight leg. This leg has its outer end supported by a timber A-frame, while the other end enters the door of the box car to be loaded. The two other legs diverge by curves and extend to the ends of the car, being supported by hangers clamped to the carlines. On this runway travel the trolleys, from each of which is suspended an L-shaped carrier or stirrup on which the tie rests, one end being supported by the man who pushes it into the car. The runway has a slight down grade into the car to facilitate the work, and the man has simply to balance the tie on the stirrup. Two men unload the ties from the truck and place them on the stirrups, two men (one to each trolley) run the ties into the car, and two men (one at each end) assist the latter in piling the ties in the car. When the tie is loaded onto the car, the man takes the trolley off the runway and carries it back with him to the platform. The machine is easily put in place and removed. Fig. 3 shows the details of construction. Fig. 1 is a view on the platform with ties being unloaded from one of the tie trucks from the retort; Fig. 2 shows the two branches of the runway inside the car, with one tie being swung into place and another entering the car.

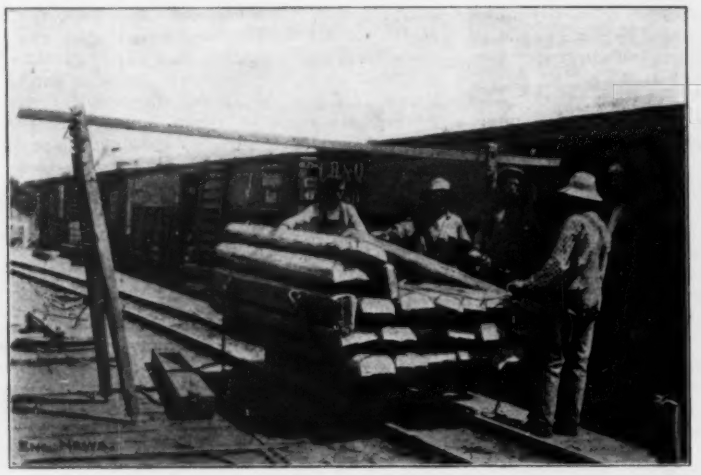


FIG. 1. MACHINE FOR LOADING RAILWAY TIES INTO CARS.
F. J. Angier, Sheridan, Wyo.; Inventor.

FIG. 2. INTERIOR OF BOX CAR WITH TIE-LOADING MACHINE IN OPERATION.

This device has been in use at the works at Sheridan, Wyo., for about two years, and Mr. Angier states that six men with the aid of the machine will do the same amount of work as ten men without it. A gang of men will load from 2,000 to 4,000 ties in 10 hours, depending upon the size of the tie. On Sept. 1, 1902, a gang of six men with the machine loaded 3,325 large treated hewn ties from the tie trucks into box cars in nine hours. This was at the rate of a little over six ties per minute, or one tie every ten seconds. There was no effort to make a record, this being simply a little better than the average rate per day. When timed, the men unloaded a truck of 30 heavy ties in 1 min. 55 sec., which is a little better than one tie in every four seconds.

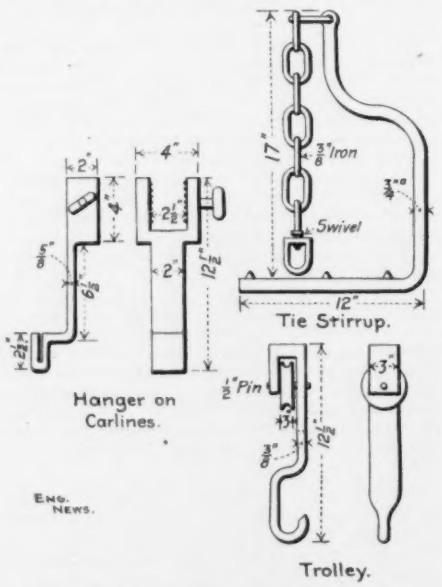


Fig. 3. Details of Tie-Loading Machine.

While the machine was specially designed for loading ties into box cars, it may be used for loading them into open cars by the addition of light portable A-frames at the ends of the allows frames fitted to the stake pockets to support the overhead runway. When used for loading ties at the preserving works, the ties are delivered on a platform close to the car, so that only short length of runway is required outside the car. For loading at the yards, however, this runway might be extended through the yards, being supported by portable frames, and shifted as required. The machine might also be adapted for use in handling and loading freight at freight houses, etc., and for other purposes.

THE CORRINGTON AIR BRAKE.

Inventors of improvements in the air brake for the past dozen years have had a difficult problem to solve, viz., to graft their improvements upon the present standard system without at all affecting its interchangeability. In other words, any new air brake in order to receive the attention of the railway companies must not interfere at all with the perfect working of the present apparatus. It must operate as they operate in application and release and at the same time, if it is to command the attention of railway officers as an improvement, it must do certain things which the present brakes cannot do.

It is claimed that these difficult conditions have been fulfilled by a brake apparatus recently invented by Mr. Murray Corrington, and which is shortly to be placed on the market by the Corrington Air Brake Co., of 40 Wall St., New York city. At present the company is installing machinery in its factory, and is not in a position to fill orders. We have been furnished, however, by the Vice-President of the Company, Mr. Chas. Hansel, M. Am. Soc. C. E., with the following description of the operation of the new brake, and of the features in which its operation differs from that of brakes now on the market. Mr. Hansel's description is as follows:

The Corrington air brake system utilizes all of the auxiliary reservoirs, brake cylinders, cut out cocks, air pumps and governors, exactly the same style and manner as now in use. The triple valve, engineer's valve and high speed pressure valve of the Corrington system are interchangeable as to position with the Westinghouse system, as they can be placed in identically the same position respectively as they now occupy on the locomotives and cars equipped with the Westinghouse system. Consequently, the new results offered by the Corrington system may be obtained by the railways on all new equipment without increased cost, and all old equipment can be altered to secure the same results at the slight cost necessary to change the triple valves on the cars, and if desired, the engineer's brake valve on the locomotives.

SPECIFIC CLAIMS.—The new brakes gives increased control both in setting and releasing, and overcomes to a much greater extent than do the

brakes hitherto in use, the difficulties presented by dirty or defective triple valves or irregularity of brake cylinder piston travel. This is accomplished by a device automatically applying full train line pressure to release the brakes when required. Overcoming the irregularity of release due to the causes stated above is of the greatest importance, reducing, as it does, the danger and expense incident to breaking trains in two, especially at slow speeds, where the failure to release one or more brakes toward the rear end of the train is now the too frequent cause of the parting of freight trains.

Another and more important feature is that the *auxiliary reservoir may be recharged without releasing the brakes*, thus dispensing with the retaining valve, the insufficiency of which to give the desired control is especially evident in the use of loaded gondola cars of high capacity. On roads with long, steep grades, this advantage is self-evident, although rather costly experience, even on roads without such grades, has demonstrated that this is a consummation greatly to be desired. The control of the train is thus placed entirely in the hands of the engineer, avoiding the necessity of the train crew acting independently, and too often disastrously.

One of our most prominent roads has gone so far as to discontinue the use of the present air brake on all freight trains when descending a heavy grade, and as a consequence is handling down this grade its heavy freight traffic by hand brakes at a slow speed. The ability to keep air brakes continuously applied, and maintain auxiliary reservoir pressure with which to stop when necessary, means to this and many other roads speed and safety in descending grades.

As corollaries to the recharge without release feature of the new apparatus:

1. The brakes may be set and released any number of times without the possibility of the engineer finding no air in the auxiliary reservoir to meet an emergency.

2. With the engineer's brake valve handle in the recharge position sufficient pressure to offset train line leaks is thrown into the train line while the brakes remain applied, thus preventing the brakes applying harder than intended, which is at present of frequent occurrence, owing to the failure of the present systems to supply air to offset such leaks when the engineer's valve has been placed in the "lap" position.

3. With the return of the engineer's brake valve handle to the recharge position, after each reduction of train line pressure, the air pump starts immediately and main reservoir pressure is regained simultaneously with the recharging of the auxiliaries. The importance of this much more continuous use of the pump, instead of the spasmodic and necessarily violent calls made upon it by the apparatus in use at present, can hardly be overstated.

As the air pump is used more evenly and continuously, it requires less capacity in the pump and main reservoir than with either the Westinghouse or New York air brake systems. Consequently, it will not be necessary to increase the size of the pump and main reservoir as is now being done to accommodate the heavier train loads, and owing to the avoidance of spasmodic action of the pump by the adoption of the Corrington system, the cost of maintenance of the pump will be considerably reduced.

Another and most important advantage of the Corrington engineer's valve and high speed and high pressure control apparatus is its simplicity in comparison with the present system. In order to provide for the two feed valves necessary for all high speed or high pressure control apparatus, the low or normal pressure feed valve must, in the present system, be cut out when the high pressure feed valve is to be used. In the Corrington system both feed valves are attached directly to the engineer's valve, and are thrown in or out of action by the brake handle alone, thus dispensing with detached feed valves and with the cut out or reversing cock and connecting piping, simplifying the operation of changing from low to high pressure. This result is attained by a novel rearrangement of ports and cavities in the rotary valve and valve seat without increasing the size of the engineer's valve. The entire high speed and high presure control apparatus of the Corrington system is much simpler than the apparatus in present use, consisting only of about one-half the number of parts.

The advantages of the results to be secured in the Corrington system involves no transition period. The triple valve is constructed in two parts, so designed as to make it practicable to cut out the recharge release part in a similar manner to the operation of the present retaining valve. The object of this is apparent. It is to be expected that the extra switching necessary to get cars equipped with the Corrington recharge release device next to the engine will be as willingly performed as was the case before the present nearly universal use of the Westinghouse brakes was attained. If, however, owing to circumstances, it is inconvenient to place the car so equipped next to the engine and it should be left in the train among cars equipped with Westinghouse or New York triples, then if it is desired, the recharge feature may be cut out as conveniently as the retaining valve is now operated. The Corrington triple then performs its functions in a similar manner to its neighbors with the advantage obtained from the Corrington release mechanism, insuring the release of the brakes on that car when normal train line pressure is attained should the release not have been previously affected. With the engine and tender alone equipped with the Corrington recharge release mechanism in the place of the present engineer's brake valve and triple valve, the advantages in train control are apparent. The addition of each car at the head end of the train is so much more gained in train control with no disadvantage whatever as far as the operation of the other brakes on the train is concerned.

COMMITTEE REPORTS OF THE ROADMASTERS' AND MAINTENANCE-OF-WAY ASSOCIATION.

At the convention held in Milwaukee last week a number of papers and committee reports were presented, abstracts of most of which will be found in our report of the proceedings, in another column. We give below, however, abstracts of two of the longest reports on the subjects of greatest interest to engineers:

WOODEN, METAL AND COMPOSITION TIES; TIE-PLATES, AND PRESERVATION OF TIES.

With nearly 250,000 miles of railroad track (main lines and sidings) consuming annually 100,000,000 cross-ties at an approximate cost of about $50,000,000, it is not strange that the source of supply, quality of material and preserving methods should be so earnestly discussed by those interested in the maintenance-of-way department. The increasing demand for and enormous expense of this single article will, doubtless, keep the subject a very live one until the expense per mile for tie renewals is reduced by prolonging the life of wooden ties or substituting a more durable material.

Our supply of tie timber in many sections of this country, adjacent to transportation lines, is getting scarce; and, by reason of forest fires, the lack of interest in timber culture, and the great demand for lumber, ties and structural material, we can scarcely expect this class of timber to become less valuable than it now is. Yet, notwithstanding these adverse conditions, it is the opinion of your committee that through modern preserving methods, good roadbeds, heavier rails and a liberal use of metal tie-plates, soft and commonly called inferior timber will prove to be reasonably satisfactory, and wooden ties will continue to be the material generally used in this country for many years.

Some years ago the cost of rail renewals exceeded the cost of tie renewals, but now this is reversed and the tie renewal expense exceeds the former. This may, no doubt, be accounted for through the use of large quantities of inferior, untreated timber, increase in weight of rolling stock and high speed of trains. A few lines seem to have succeeded in keeping down the expense of tie renewals below others, carrying about the same tonnage, but this seems to be frequently attained by allowing ties to remain in the track two or more years after they should have been taken out, thereby showing—on paper—a comparatively small charge to the tie renewal account; but very often this saving is made at the expense of the rails, rolling stock and cost of operating.

The average life of ties is determined largely by the treatment they receive before they are laid in the track, and also with reference to the locality in which they are used—the soil, climate, traffic, per cent. of tie support under the rail and amount of labor used in maintenance. Up to this time, the tie record reports of our American lines have been very imperfect and of little value in determining the relative merits of cross-tie timber and preserving methods; but recently this matter has been receiving the attention of the heads of maintenance-of-way departments, and hereafter will, doubtless, be more satisfactory. The experiments now being made in the chemical treatment of ties by railroad companies, the United States Department of Agriculture and technical institutions all over the country will probably result in a great deal of timber, heretofore rejected, being made available and possibly more lasting for ties than the ideal untreated white oak.

The treating of timber with good preservatives has been practiced in Europe for a great many years; but not until about 1885 do we find any record of cross-ties having been, to any great extent, treated in this country. Since then, however, a large number of plants have been established, and the use of wood preservatives has been adopted by many of our largest western railroad systems.

There are a number of methods in use, which are no doubt familiar to those who have given the subject study, but only about three have received much attention. 1. Creosoting. This is probably the best wood preservative and is the most expensive. 2. The Wellhouse or zinc, tannin and glue process, consists of the chloride of zinc with tannin and glue. This is a very good method, but has been discontinued by some companies on account of the tannin and glue and the additional labor at the treating plant adding a few cents to the cost of each tie. 3. Burnettizing, which consists of the use of chloride of zinc only. This is the cheapest of the methods mentioned, and is the process in use on the Atchison, Topeka & Santa Fe Ry. and the Southern Pacific Ry., both pioneers in the work. The creosote and chloride of zinc are the preservatives in the three processes mentioned, the tannin and glue being used only to keep the antiseptics from leaching out of the timber. "Burnettizing" may prove to be satisfactory in arid districts or localities where the rain fall is light, but it is doubtful if it is the most economical process to adopt in other places.

To get the best results from our ties, we should begin in the forest. Tie timber should be cut in the fall or early in the winter, when it contains the least fermentable sap and will dry out evenly. Ties should be thoroughly seasoned before they are treated, and then properly piled after treatment until they are well dried before being laid in the track. Any timber, when thoroughly dry, will resist decay for years. In fact, without moisture, it would not decay.

Ties should be of even thickness and tamped their full length in ballast or other material that will quickly dry out. Track spikes should be smooth and well pointed to prevent damage to the wood fiber. Spike lining and redriving of track spikes, being very destructive to wooden ties, should be avoided as much as possible. Tie-plates, not less than ¼-in. in thickness, should be used on every soft wood tie in main tracks. The use and advantages of metal tie-plates are so well known to track men that it seems unnecessary for us to say much about them. They should be punched to perfectly fit the rails when the spikes are driven straight.

The best results are obtained when the tie-plates are embedded in the ties before they are put in the track. This is sometimes done by a tie-plate press, in which two plates are set with one blow, the power used being steam. The cost per plate is from ½ to ¾-ct., and from 3,000 to 4,000 ties can be plated in ten hours. Another tie-plating machine is operated by hand, and the power is derived from an eccentric. Ten to twelve men can full plate about 1,000 ties in a day. Both machines are, as a rule, only operated in material yards. We know of no satisfactory device for embedding plates without removing the ties from the track.

The rapid deterioration of wood makes the use of metal or composition cross-ties desirable, and, while a great many patents have been issued in the last 60 years (about 500 for metal and 20 for composition), we know of no considerable number having been laid in tracks in this country. This is, perhaps, principally due to their large cost in comparison to wooden ties. A great many are in use in foreign countries where timber is scarce, and are said to be giving satisfactory results; but it should be remembered that, as a rule, their road beds are more permanent, with better drainage and carry lighter locomotives and cars than our American lines.

The conditions on the majority of our western lines do not yet appear to be just right to give us the best results from metal ties. We need better ballast and more perfect drainage to prevent corrosion. We do not know of any patented composition ties in general use, but experiments are now being made with a combination of cement and metal for which a good deal of merit is claimed, but they have not yet passed the experimental stage.

J. E. McNeil, M. Sullivan, P. H. McFadden, W. J. McClaren.

The greater part of the discussion on this report was postponed until the evening session, when Mr. C. Buhrer (L. S. & M. S. Ry.) described the steel ties in use on that road (Eng. News, March 20), and also a form of concrete-steel tie designed by him for utilizing scrap rail, small structural

shapes, etc. About 15 of these ties have been laid in the northbound main track of the Chicago & Northwestern Ry. at the Allis Station (Milwaukee), where they were inspected by a number of the members. These ties we shall describe later. The concrete-steel ties of the Harrell system, laid near the Union Station at Chicago, were also described, but Mr. Allen (C., B. & Q. Ry.) stated that they had been removed after about a year's service, the concrete being badly scattered. The concrete-steel ties of the Pere Marquette Ry. (Eng. News, April 3 and Aug. 28) were also mentioned. Mr. F. R. Coates (Chf. Engr., C. G. W. Ry.) remarked that the Great Northern Ry. had been experimenting with "self-tamping" ties of triangular section, laid with the apex downward. The President, Mr. I. O. Walker (N., C. & St. L. Ry.) thought that while concrete ties are of interest, the experience with them is so very limited as yet that the matter of the preservative treatment of wooden ties is of much more importance at the present time. Mr. McEniry (C., R. I. & P. Ry.) spoke of treated hemlock ties which became unfit for use in about 18 months, though he could not say whether this was due to defective timber or improper treatment.

On request of the President, Mr. E. E. R. Tratman (Engineering News) entered into some discussion as to tie preservation. He pointed out that while creosoting is generally considered as the best and most effective process, yet that the supply of creosote of proper quality is so limited in this country and so expensive that the process is very little used, especially as a much cheaper process of nearly equal efficiency is available. In this latter process, chloride of zinc is used as the preservative, but in all processes the real efficiency depends upon how well the treatment is carried out. In a majority of cases the Wellhouse system is employed, which includes a treatment with glue and tannin solutions to seal the wood and prevent water from leaching out the preservative. Where ties are used in practically rainless districts, however, the plain Burnettizing system, which includes simply the treatment with the chloride zinc solution, is used quite extensively. Several new Burnettising plants are now being erected, some by railway companies and others by large lumber companies which have important tie contracts. He explained the methods of marking the treated ties by dating stamps or nails, and referred to the experiments with treated ties now being made on some of the Texas railways, under the direction of the Department of Agriculture. One great difficulty in ascertaining the real value of treated ties is the very incomplete system of records on most railways, which makes it almost impossible to ascertain the location of any lot of ties after a few years, or to ascertain the history of any particular ties found in the track. Mr. W. M. Camp (Railway Review) was also invited to speak, and described the government experiments above noted, and explained that where the Wellhouse (zinc-tannin) system has given place to the Burnettizing (plain zinc) system, it has been generally for financial reasons, and not on account of any inferiority in the former system. On motion of Mr. F. R. Coates (C. G. W. Ry) both Mr. Tratman and Mr. Camp were appointed members of the Tie Committee, and the committee was instructed to further investigate the question of the use of and experience with treated ties and substitutes for wooden ties.

NEW AND IMPROVED APPLIANCES FOR USE ON MAINTENANCE OF WAY.

1. LEVELERS OR SPREADERS.—These are recommended on all bank widening or embankment work and ballasting for additional parallel tracks. A properly constructed leveler with a good engine will level back more material in 30 minutes than 30 men will handle with shovels in 10 hours.

In general construction, all levelers are similar, but the methods of extending, raising and lowering the wings differ in the different machines. In some the wings are raised and lowered by jacks; in others by blocks and tackle, while still in others by compressed air. These machines can be divided into two general classes: A, those in which the spreaders or wings open downward and outward; and B, those in which the spreaders or wings fold against the sides of the car. We would recommend on all work, such as previously mentioned, the use of the levelers operated by air with wings on both sides of the car.

2. BALLAST CARS.—In order to obtain the best results and most economy in handling ballast needed for maintenance, the most improved self-loading cars should be used. By the use of these cars material can be deposited quickly where needed and traffic will not be delayed. We would recommend the use of a ballast car of the gondola style, holding about 30 cu. yds. of material, with the bottom of the car so arranged as to rapidly deposit the material where needed.

3. TRACK-MOVING CAR.—This is a new device, having recently been placed on the market, and we herewith give a general description of the car:

A stout pole 32 ft. long extends back from the car, pressing sidewise against the ball of the rail. When the track is being moved to the right, the pole extends from the left-hand corner of the car to the inside of the right-hand rail. This pole is braced about midway by a light pole attached to the right-hand corner of the car, and it is also held in position by an iron rod, which connects the right-hand corner of the car with the extreme end of the pole, and which is adjustable. At the outer end of the pole is a pulley 15 ins. diameter, through which the pressure is exerted.

Before starting to move the track, the ballast is taken away from the ends of the ties (but none from between the ties), and a small section of the track is moved to the right with bars in the usual manner the desired distance; after this is done the pole is adjusted so as to press against the rail in its new position, and when the car is pulled forward by a locomotive, or pushed backward, the track is crowded over to its new position as the car proceeds. At the rear end there must be struts fastened on the car, and before starting to move track, one of the struts must be put in position between the end sill of the car and engine tender, and made tight.

The car must be heavily loaded with iron to give it stability. At the forward end a pulley is fixed to top of a post about 9 ft. high; over the pulley runs a wire cable attached to a crab, by which the pole is raised. The process of moving track has been described throwing to the right; but the pole braces are interchangeable; so that it is not necessary to turn the car around to move the track to the left.

4. FROGS.—These should be divided into the following classes: A, Spring rail; B, Rigid; C, Movable wings; D, Jump frogs; E, Crossing frogs. A, Spring-rail frogs are of different varieties, such as the ordinary movable or spring rail, which is operated by a spring placed near the heel of the wing rail, or by a bolt with the springs placed near the top of the frog. Also we have the different styles of patent spring-rail frogs now on the market. We would recommend that spring-rail frogs be used on main tracks, excepting at junction points or double-track or four-track endings; the frog to be 15 ft. long and of a No. 10 angle. They should be provided with the necessary sliding plates to insure a free movement of the loose-wing rail. The springs to be placed near the heel of the wing rail. The frog should be provided with a stationary brace or stop blocks set the proper distance to avoid the wing rail opening up beyond the safety line. The holding down device and re-enforcing strap should be of some approved design. A steel raising block to carry worn wheels to be placed in the crotch immediately behind the points of the wing rail of the frog. Also the wing or movable rail should be grooved.

B. No. 10 rigid frogs should be used on all side tracks and in all yards. Also No. 15 rigid frogs at junctions, double-track or four-track endings. In special cases exceptions can be made according to the available room. These frogs to be of a plain filled and bolted pattern, and tie-plates to be used under them. A filler properly bolted to be placed in the throat of the frog. A steel raising block to carry worn wheels to be placed in the crotch immediately behind the point.

C. There is a class of frogs in which the wheels of the cars move the wings from one side to the other according to the way the switch is thrown. It is claimed for these frogs that the wings and points are saved from excessive wear.

D. There is also on the market a frog which we call a jump frog, which is operated the same as a switch, and in which a frog laps over the main or running rail. By the use of this the main line is left unbroken when the frog is set for straight track.

E. Crossing frogs and slip crossings. Where the ordinary rigid crossing is used, it should be constructed of three rails with plates at the angles. Of these three rails, one is the easement rail, the next the main-track rail, and the third the inside guard rail. In any crossing where the number of the angle exceeds that of a No. 6, movable points are recommended.

5. SWITCH POINTS.—In all main-line switches, excepting in special cases, points 15 ft. long should be used. Switch points should be so planed so that they will fit up against the stock or main track when set for either main or side track. The points should be re-enforced and be connected by two rods. Plates should be placed on every tie under the point and the latter should be properly braced. Gage plates should be used at the point and on the tie immediately ahead of same. There should be stop blocks near the heel of the point. Where switches are used at double-track ending, etc., fast running being the main feature, points 24 ft. long should be put in, and of the same general construction as described in regard to the 15-ft. points, excepting with four rods. In yards, points 10 ft. long with one rod and not re-enforced are recommended. Plates should be placed on each tie under the point and a gage plate directly at the point.

6. CATTLE GUARDS AND SIGNS.—We would recommend that a surface guard be used, properly constructed, so as to turn stock. No general recommendation as to style can be given, as in some states the construction style of cattle guards are covered by law. Signs should be constructed of metal. This, of course, except... way crossings, where the signs are provided for ...

7. FOOT GUARDS.—We recommend that metal guards be used on the heel of all split switches, ... each end of frogs and guard rails. No switch, frog or guard rail should be called complete without the guard.

F. R. Coates, C. Buhrer, C. B. Teller, W. A. Hill, ... Jones.

A LONG-SPAN THREE-HINGED MASONRY ARCH.

In recent volumes of Engineering News ... have appeared numerous articles describing ... ropean work in the building of masonry ar... The examples illustrated have in each case ... notable either for large size or for unusual ... arrangement. In addition they have, collectively, involved a further interest inasmuch as ... bring out a strong and widespread tendency among the continental engineers to build ... bridges as masonry arches wherever the circumstances render this at all practicable.

In the present article we show another specimen of work in this field, which is interesting from both of these viewpoints. The masonry arch bridge in question is nearly 210 ft. in span and hence ranks among the large stone arches of the world. In proportions it is especially noteworthy, since the rise of the arch is about one-tenth of the span; of the details we note the use of three hinges, at springing and at the crown. This bridge further emphasizes the general tendency, above referred to, toward masonry arch bridges, since its location is one that would, in this country, at least, be considered distinctly unfavorable to an arch construction in masonry. The brief description following is taken fron an article in the "Centralblatt der Bauverwaltung;" the incompleteness of our numerical data is due to a similar lack in our source of information.

The structure in question, a highway bridge, crosses the river Isar at the village of Bogenhausen, in Bavaria. An iron bridge was built on the site in 1876. In 1899 the bridge was destroyed by high water, and it was decided to replace it

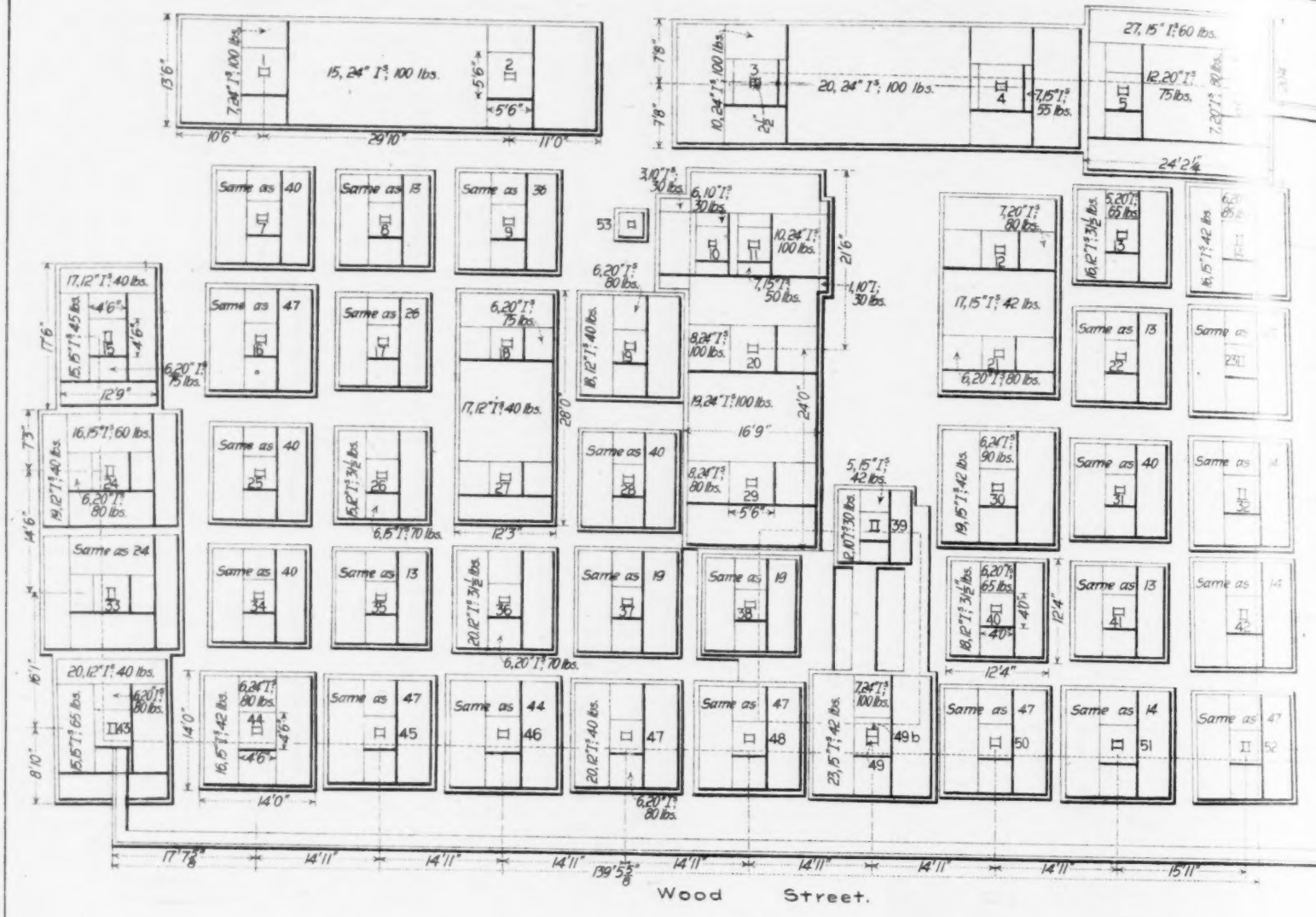
A Long-Span Three-Hinged Masonry Arch Over the River Isar, in Germany.

by a stone structure. This new bridge crosses the river in a single arch span, as can be seen in the illustration. The main dimensions of the arch are:

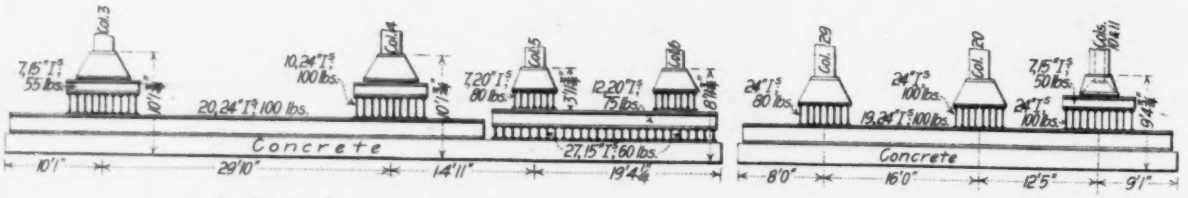
Span, ft.	209.9
Width, ft.	59.0
Rise, between centers of hinges, ft.	21.4
Thickness of arch at crown, ft.	3.4

The width given includes two sidewalks each 10 ft. wide, leaving a 39-ft. roadway. As previously noted, there are hinges at the springing lines and at the crown; these are of steel (probably cast). The illustration shows that the roadway is carried by small relieving arches which foot on the arch ring by means of spandrel cross walls. The arch ring as well as the body of the bridge is composed of limestone; granite blocks are used where the steel hinge castings bear against the masonry. The abutments are of concrete, for which Marienstein cement was used. The arch ring masonry is laid in cement mortar, made with Dyckerhoff cement.

The bridge is about completed at present, construction having been begun in November, 1901. Over each abutment will be placed two stone pylons to give the appropriate architectural finish to the structure. The keystones of the arch will be fitted with copper panels showing symbolical designs in relief. The decorative part of the design is due to Prof. Fischer, of Stuttgart. The firm of Sager & Wörner was the contractor for the entire bridge.

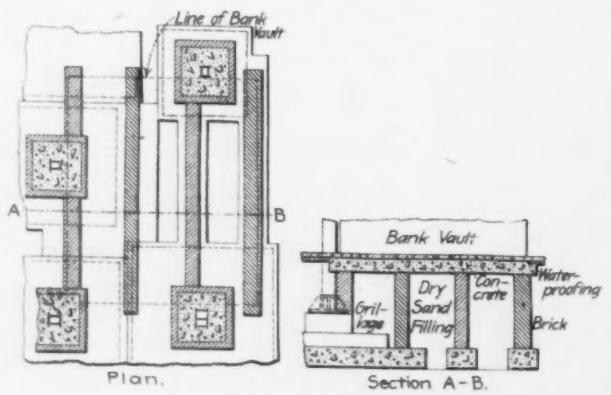


PLAN.

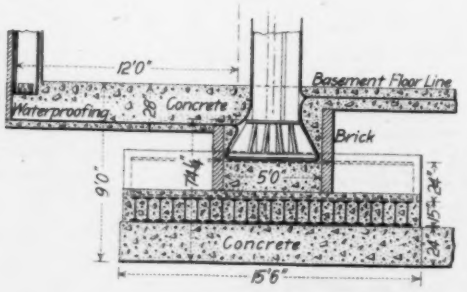


A.—Footing for Cols. 3, 4, 5 and 6.

B.—Footing for Cols. 10, 11, 20 and 29.



C. D.—Plan and Section of Bank Vault Foundation.



E.—Detail Section of Column Footing Plan.

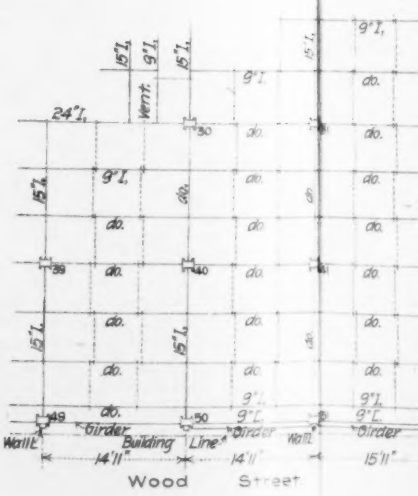


FIG. 2. PORTION OF FRAMING PLAN FOR FLOORS 6, 8, 10, 12, 14, 16, 18 AND SHOWING TYPICAL FRAMING.

FIG. 10. PLAN AND DETAILS OF FOUNDATIONS.

THE STEEL FRAMEWORK OF THE FARMERS' B

Alden & Harlow, Architects. Carnegie Steel Co., Engineers. Corydon T. Purd

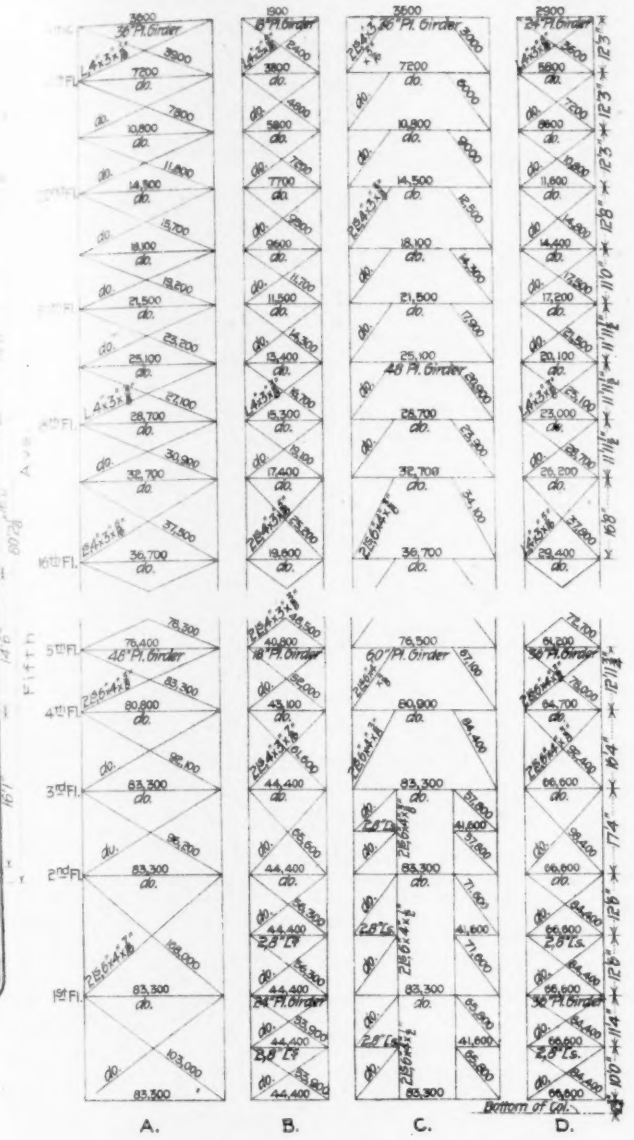
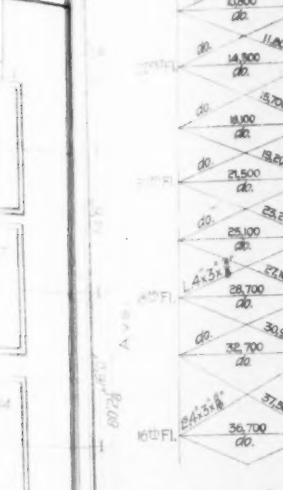


FIG. 5. PART DIAGRAMS OF WIND-BRACING.

A. Bay Col. 3-4; B. Bays Col. 18-27, Col. 12-21, Col. 20-29;
C. Bay Col. 1-2; D. Bay Col. 15-24.



N OF FRAMING PLAN
10, 12, 14, 16, 18 AND 19,
TYPICAL FRAMING.

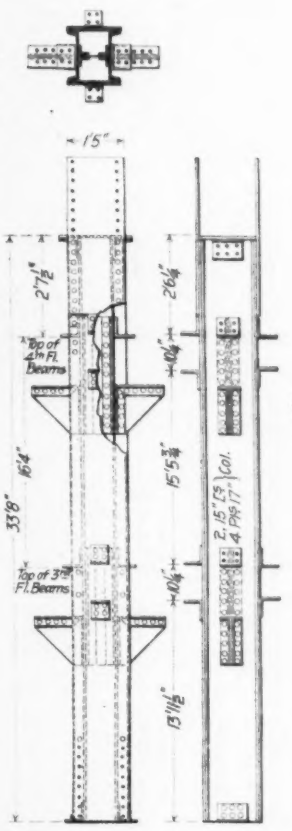
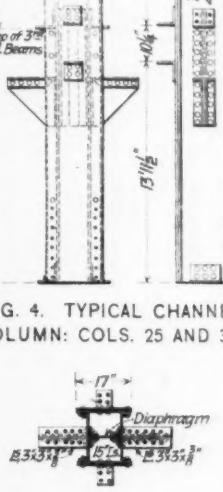
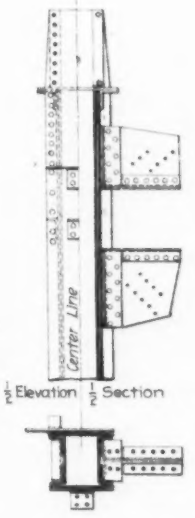


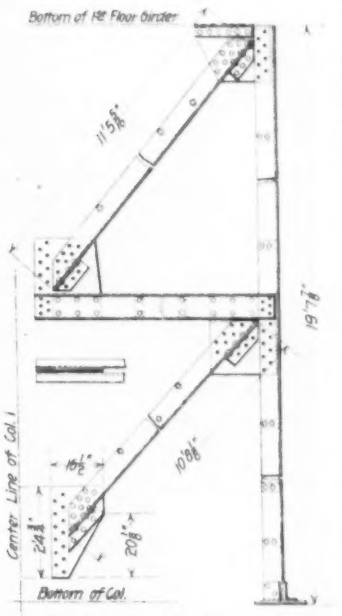
FIG. 4. TYPICAL CHANNEL COLUMN: COLS. 25 AND 34.



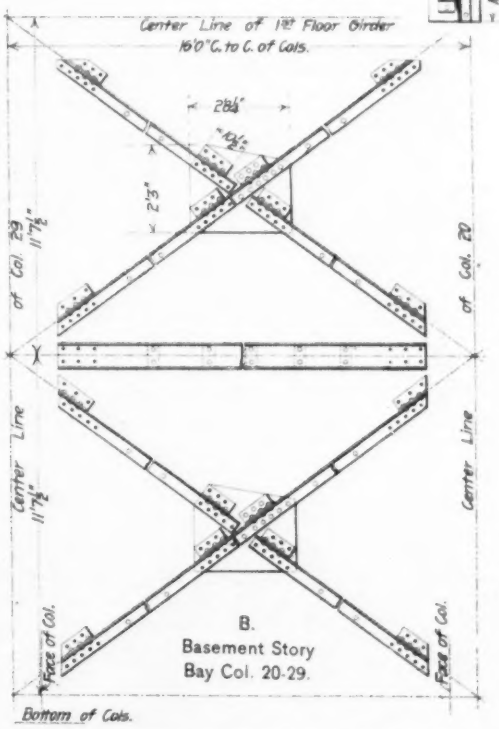
C.—Typical Interior Bracket.



A.—Connection of Bracing to Column.



C.—Basement Story Bay Col. 1-2.


Center Line of 1st Floor Girder
16'0"C. to C. of Cols.
Center Line of Col. 29
Center Line of Col. 20
Face of Col.
Face of Col.
Bottom of Cols.

B.
Basement Story
Bay Col. 20-29.

FIG. 6. TYPICAL WIND-BRACING DETAILS.

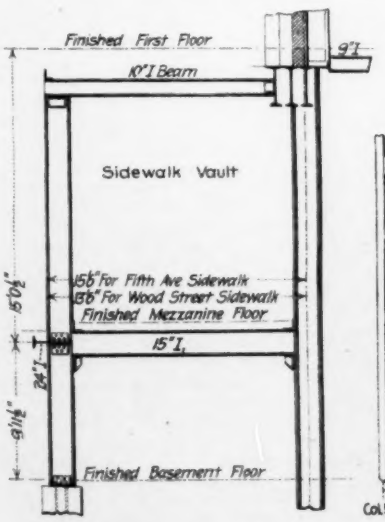
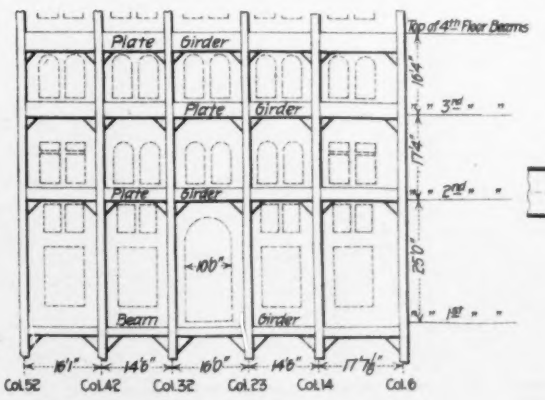
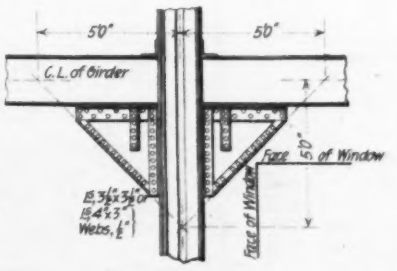


FIG. 9. CROSS SECTION THROUGH SIDEWALK VAULT.



A.—Lower Portion of Fifth Ave. Front.



B.—Typical Front Wall Bracket.

FIG. 7. ARRANGEMENT AND DETAILS OF KNEE-BRACKETS.

E FARMERS' BANK BUILDING, PITTSBURG, PA.

Corydon T. Purdy, Engineer for Foundations. Geo. A. Fuller Co., Contractors.

CHAS. HART, LITH., 96 VESEY ST., N. Y.